IDENTIFICATION OF POTENTIAL BEACH-NESTING BIRD HABITAT TO BE SET ASIDE IN MUNICIPAL BEACH MANAGEMENT PLANS

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APPENDIX

1.0 BACKGROUND

Persistence of beach-nesting bird populations in New Jersey is inhibited by a lack of suitable habitat as a result of dense coastal development, significant human disturbance, pressure from non-native and human-adapted predators, and the consequences of habitat-insensitive beach stabilization practices. In the wake of Superstorm Sandy, The United States Fish and Wildlife Service (USFWS) awarded Rutgers University funds under the Disaster Appropriations Relief Act of 2013, Public Law 113-2 to identify and prioritize for protection newly created beach-nesting bird habitat in New Jersey. The target species identified in the project are piping plovers (*Charadrius melodus*), least terns (*Sterna antillarum*), black skimmers (*Rynchops niger*) and American oystercatchers (*Haematopus palliatus*). The federal and state level conservation status of these species is listed in Table 1.

As a result of conservation measures included in Programmatic Biological Opinions issued by the USFWS New Jersey Field Office (NJFO) regarding the effects of federal beach nourishment on the Atlantic coast of New Jersey on piping plovers (and sea beach amaranth, *Amaranthus pumilus*) within both the New York and Philadelphia Districts of the U.S. Army Corps of Engineers, beach management plans are required for all municipalities and other landowners who receive beach fills. The purpose of the management plans is to provide a framework for cooperation among municipal landowners, the New Jersey Division of Fish and Wildlife, and USFWS NJFO in the stewardship of federally and state-listed endangered and threatened beach-nesting birds and flora. The goal of the plans is to increase nesting success and abundance of beach-nesting birds, as well as protect suitable habitat at a state level by minimizing the impact of human disturbance, predators, and beach management practices at individual sites.

Table 1. Conservation status of target beach-nesting bird species

Species		Federal Status[1]	State Status[2]
American oystercatcher	*Haematopus palliatus*		special concern
black skimmer	*Rynchops niger*		endangered
least tern	*Sterna antillarum*		endangered
piping plover	*Charadrius melodus*	threatened	endangered

[1]United States Endangered Species Act of 1973
[2]New Jersey Endangered and Non-game Species Conservation Act (1972)

2.0 PURPOSE

This document delineates the spatial extent of potential beach-nesting bird habitat in the State of New Jersey, extending from Gateway National Recreation Area – Sandy Hook Unit south to Cape May. The information provided here was extracted from a statistically robust piping plover distribution model generated from a long-term dataset of nest locations and publicly available landscape-level spatial data from a variety of sources. The goal of this document is to assist the USFWS and New Jersey Department of Environmental Protection – Endangered and Nongame Species Program (ENSP) in working with municipalities and other beach landowners in the state to set aside portions of beach that have the highest probability of nesting occurrence by beach-nesting birds of conservation concern and to manage those areas to promote successful reproduction. Adding new habitat zones for these species releases competition for breeding sites within designated natural areas and provides dispersal areas for juvenile birds (Cairns 1982, Cohen et al. 2009). They also provide in-season refuge sites when primary nesting areas are inundated with storm tides, and they reduce the dependency on any single site for New Jersey's yearly reproductive output.

3.0 HABITAT REQUIREMENTS FOR BEACH-NESTING BIRDS

Beach-nesting birds have evolved to persist along the highly dynamic shorelines of sandy beach ecosystems. Consistent wind and wave energy maintain these ecosystems in an early successional state, with the resulting habitat consisting generally of sparse, low-lying vegetation and a mottled sandy substrate covered with shells and pebbles (e.g., Cohen et al. 2008, Maslo et al. 2011; Figures 1 and 2). Breeding sites occur generally in areas of low elevation with gently sloping, low-lying dunes (e.g., Mazzocchi et al. 2005, Maslo et al. 2011), and ideally nests are positioned far from both the high tide line and the seaward toe of the dune line. Such locations offer nests both protection from storm tides, as well as lowered detection probability by avian and mammalian predators (e.g., Lima 2009, van de Pol et al. 2010). In natural beach systems, beach-nesting birds often occupy unstabilized inlets, recurved spits, and overwash fans, which are flat sandy areas created by storm-driven dune blowouts. However, beach stabilization practices generally prevent the creation and maintenance of natural habitat features except in rare severe storm events. Therefore, in areas where beach stabilization structures are prevalent, beach-nesting birds must rely more heavily on human-administered management to achieve sustainable reproductive success.

Human disturbance can significantly reduce the breeding success of beach-nesting birds through direct mortality (i.e. trampling of eggs or chicks, predation by dogs) or indirect effects (i.e. nest abandonment, preventing chicks from accessing foraging areas). These factors can reduce overall reproductive success at breeding sites (Melvin et al. 1994, McGowan and Simons 2006). Therefore, maintaining suitable habitat quality, particularly in densely human-populated areas requires management intervention to reduce disturbance. Such measures include limiting pedestrian and vehicle access, restricting dogs and fireworks, buffering nesting areas from

human recreational activities, and minimizing the impact of municipal beach and dune maintenance (i.e. beach-raking, movement of sand).

Piping plover chicks are precocial, meaning that they are mobile and able to feed themselves within hours of hatching (Melvin et al. 1991). Although oystercatcher chicks rely on their parents for food, they do not remain at the nest-site during the pre-fledging stage (AMOY Working Group 2014). Availability of and unrestricted access to foraging areas (i.e. intertidal zone, wrack line, tidal ponds) are critical for these individuals to reach fledgling stage successfully (Loegering and Fraser 1995, Sabine et al. 2008). If tidal ponds or low-energy bay shorelines are not present at a breeding site, suitable beach-nesting bird habitat should include "no-rake" provisions at the high tide line fronting nesting areas, as well as reduced human activity at the intertidal zone.

Figure 1. Typical beach-nesting bird habitat consists of mottled substrate, low-lying dunes, and sparse vegetation (Photo credit: Todd Pover)

Figure 2. Piping plover (*Charadrius melodus*) nest located within a patch of shells and adjacent to American beach grass (*Ammophila breviligulata*) (Photo credit: Brooke Maslo)

4.0 PREDICTING BEACH-NESTING BIRD HABITAT POTENTIAL

Piping plovers are considered an umbrella species for other beach-nesting birds (Hecker 2008). In addition, the USFWS North Atlantic Conservation Cooperative (North Atlantic LCC) has designated the piping plover as a representative species in all three subregions of its boundary, standing as a surrogate for other species using dynamic beach systems, including American oystercatchers, black skimmers, seabeach amaranth (*Amaranthus pumilus*), and migrating shorebirds. While average nest-site microhabitat characteristics (e.g., vegetation percent cover, substrate) may differ slightly among species, piping plovers are consistently observed nesting in close proximity to least terns, American oystercatchers and black skimmers, indicating a substantial degree of overlap in habitat requirements. In addition, piping plovers are obligate beach-nesters, making availability of suitable beach habitat critical to their persistence. Black skimmers and American oystercatchers also establish breeding sites on salt marsh islands, and least terns have nested on rooftops in coastal areas. Finally, as solitary breeders, a sustainable piping plover population likely requires more available sites relative to its colonial counterparts. Therefore, our recommended set-aside locations for beach-nesting birds in New Jersey are generated from a species distribution model we have developed for piping plovers.

4.1 Project Area

We designated the study area as all land and water within 5 km of the New Jersey coastline from Gateway National Recreation Area – Sandy Hook Unit south to Cape May Point (approximately 250 km; Figure 3). This approach allowed us to capture all beaches, dunes, and mudflats where piping plovers could potentially occur.

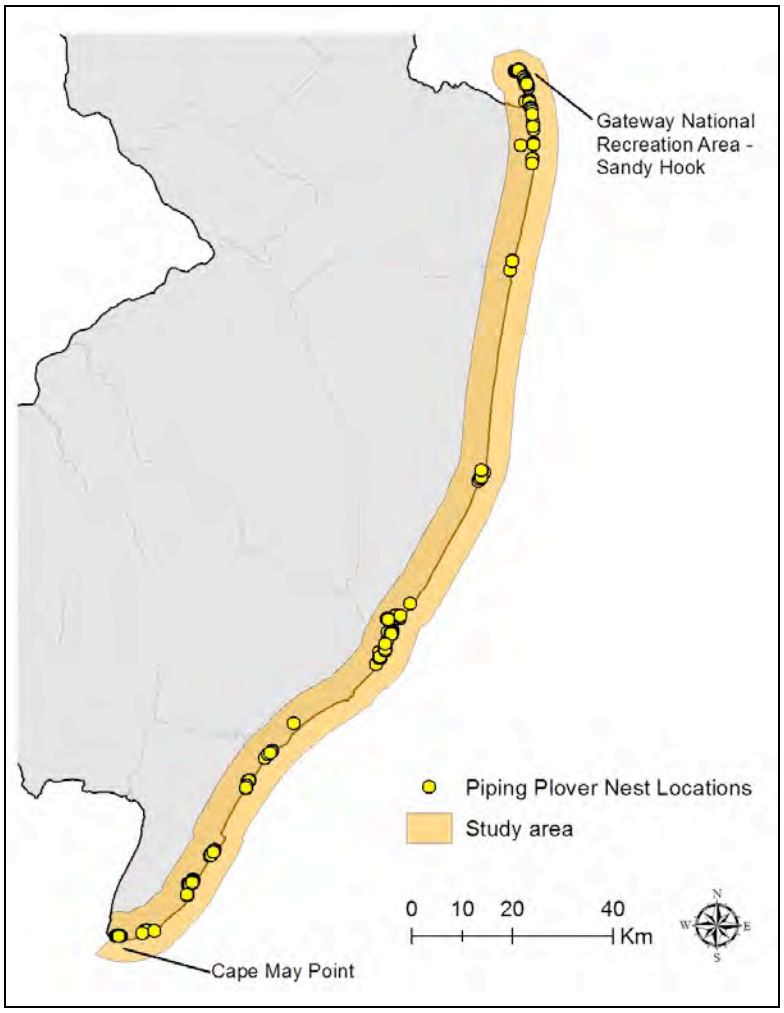

Figure 3. Study area and nest locations (2007 – 2011) used to generate the piping plover (*Charadrius melodus*) distribution model

4.2 Species Data

Trained ENSP staff and state and federal agency partners (USFWS, National Park Service, etc.) conduct seasonal monitoring of piping plovers in New Jersey from March through September each year. All beaches in New Jersey are visited at least once annually, and sites where piping plovers are observed are visited repeatedly to monitor all reproductive stages (courting, nesting, chick-rearing, etc.). The GPS coordinates of each nest location are recorded. We extracted from the full ENSP data set nest occurrence data for piping plovers for the years 2007 – 2011. To minimize bias from spatial autocorrelation, we spatially rarefied the points (Brown 2014), removing duplicate points and points that occur within 10 m of one another. The final data set included 606 nest locations (Figure 3).

4.3 Predictor Variables

We formulated 8 predictor variables in our models, which included temporally relevant, spatially explicit, publicly available information on elevation, land use and land cover, beach morphology, and distance to coastal features deemed important in nest-site selection (Table 2). All data were examined at a 10-m spatial resolution, based upon the minimum mapping unit of the coarsest environmental GIS layer (in this case elevation). We acquired digital topographic data from the United States Geological Survey (USGS) to identify elevation across the project area, and from these data we also calculated the slope (defined as percent surface grade). We also compiled detailed information on land use from existing New Jersey Department of Environmental Protection (NJDEP) data. We calculated the Euclidean distance to the high tide line, which we determined either by examining the wet/dry interface of sand depicted on the 2010 United States Department of Agriculture (USDA) Farm Service Agency (FSA) aerial imagery (for beaches), or using the 2012 coastline data generated by NJDEP for marsh and tidal flat habitats (Schupp et al. 2005). To incorporate potential pair territory size, we calculated the total beach area within 100 m using FRAGSTATS v4 (McGarigal et al. 2012). Similarly, we calculated the total marsh area within 100 m. To assess the influence of non-ocean foraging areas in nest-site selection, we calculated the Euclidean distance to non-ocean tidal waters, which included inlets, bays, and tidal ponds. We processed all geospatial data using ArcMap 10.2.2 (Environmental Systems Research Institute, Redlands, CA, 2014).

In addition to the landscape features described above, we captured the more subtle microhabitat differences among beaches in the study area by classifying them as managed or not managed for beach-nesting birds. New Jersey ENSP separates beaches into 4 management zones, detailed in Table 3. In Recreation Zones, beaches are routinely maintained for human recreation either during the summer season (Memorial Day through Labor Day) or throughout the entire year, and pedestrian and vehicular traffic is permitted from the high tide line to the seaward toe of the primary dune. Both the removal of organic matter and debris, as well as the continuous compaction of sand, maintain in these areas as a flat, monotonic landscape generally unsuitable for nesting birds. To varying degrees, areas managed for beach-nesting birds (closed areas, species protection zones, and species precautionary zones) are subject to normal successional dynamics for all or part of year. Managed areas, particularly closed areas and species protection zones, are safeguarded from human encroachment for at least the breeding season (March 15-August 31) through symbolic fencing adorned with signs and the implementation of dog, vehicle and raking restrictions. In the absence of these human influences, the upper beach experiences incipient dune formation, shell deposition, and modest vegetative growth, all habitat features deemed important in nest-site selection (e.g., Maslo et al. 2012).

Table 2. Predictor variables used to develop piping plover distribution model

Predictor variable	Description	Data source(s)[f]	
		pre-Sandy	post-Sandy
distance to high tide line	distance (in meters) to the nearest point on the line indicating the wet/dry interface of the shoreline	USDA[a] Aerial Imagery 2010 NJDEP[b] 2012	NOAA[c] Aerial Imagery 2012 NOAA 2014
distance to non-ocean tidal waters	distance (in meters) to the nearest tidal ponds; tidal rivers, inland bays, and other tidal waters; or open tidal bays	NJDEP 2007	*NOAA Aerial Imagery 2012
elevation	digital elevation model (in meters)	NJDEP 2002	USGS[d] 2012
management zone	4 classifications of beach management zones (Table 3)	NJDEP ENSP[e] 2015	NJDEP ENSP 2015
total beach area within a 100-m radius	area (in square meters) of beach within a 100-m radius	NJDEP 2007	*NOAA Aerial Imagery 2012
total marsh area within a 100-m radius	area (in square meters) of high marsh and low marsh within a 100-m radius	NJDEP 2007	*NOAA Aerial Imagery 2012
slope	surface gradient (in percent rise) derived from digital elevation model	NJDEP 2002	USGS 2012
land use	24 land use classifications (Appendix I)	NJDEP 2007	*NOAA Aerial Imagery 2012

*Post-Sandy imagery used to edit Pre-Sandy land use data to reflect landscape changes
[a]United States Department of Agriculture
[b]New Jersey Department of Environmental Protection
[c]National Oceanic and Atmospheric Administration
[d]United States Geological Survey
[e]New Jersey Endangered and Nongame Species Program
[f]Detailed information on data sources used are included in Appendix II

Table 3. Beach management zone designations in New Jersey

Management Zone	Description
Closed	closed to all public and uses except monitoring by foot during the breeding season
Species Protection Zone	open to public use, but high level of proactive protection to birds and habitat during breeding season; includes no-rake zones, no-vehicle designations, dog prohibition, symbolic fencing; human access restrictions to foraging areas
Species Precautionary Zone	open to public use, some level of protection during breeding season; temporary no-rake and no-vehicles designations (May 15 – July 15), symbolic fencing only if birds present
Recreation Zone	no protection unless species is detected at the site

4.4 Species Distribution Model

We used maximum entropy modeling software (Maxent version 3.3.3k; Phillips et al. 2006) to predict species occurrence of piping plovers across coastal New Jersey. Maxent is a widely employed species distribution modeling platform that uses a deterministic, maximum-likelihood framework to efficiently analyze species occurrence data. Using a complex, machine-learning algorithm, Maxent generates the probability of a given species' occurrence (bounded between 0 and 1) across a defined spatial area, giving insight into the spatial and environmental factors that are important to species in the selection of their habitats. Spatial areas are split into equal "cells," with the total area (or resolution) of each cell defined by the user. Maxent generates a probability of occurrence, or *suitability score*, for each cell, and then displays those scores visually as a map of predicted occurrence, with each cell reflecting the species' probability of occurrence by color. "Colder" blue colors indicate low probability of occurrence, and "warmer" colors indicate higher probability of occurrence.

Because the coastal landscape changed considerably as a result of Superstorm Sandy (October 2012), we expected the spatial extent of suitable beach-nesting bird habitat also to change in response. Therefore, our model approach was hierarchical. We first developed the piping plover distribution model using historical data, and then we projected our (pre-Sandy) model onto the post-Sandy landscape, using new environmental data layers reflective of changes in elevation, slope, and land use and land cover.

To determine the most appropriate areas to set aside for beach-nesting bird management, it was important that all beaches be equally available for management. Therefore, in the second model we hypothetically designated all beaches in New Jersey as Species Protection Zones, making them available for beach-nesting bird management. We acknowledge that some beaches in New Jersey have recreational uses incompatible with beach-nesting bird presence, and we assume that state and federal agencies will account for these locations when using this document.

We fit the Maxent model using the linear, product and quadratic model parameters and evaluated the models by using a separate test data file, consisting of nest/colony locations from the 2012 breeding season. We determined model fit by examining the area under the curve (AUC) score, which is the area under the receiver operating curve (ROC). Models with AUC scores ≥0.7 are considered to have performed well (Phillips and Dudik 2008). To determine the influence of each predictor variable on our piping plover distribution model, we examined the permutation importance values generated by the Maxent analysis. These values are calculated as the normalized percentage of the drop in AUC resulting from the random permutation of the values of each predictor variable. When predictor variables are correlated (as is potentially the case for our set of predictor variables), the permutation importance provides a robust indication of a variable's explanatory power.

5.0 IDENTIFICATION OF POTENTIALLY SUITABLE HABITAT AREAS

5.1 Model Results

The Maxent model performed well, returning an AUC value of 0.967 (Table 4). Distance to the high tide line was the most significant predictor of piping plover occurrence, with nesting areas predicted to occur within 4-100 m away from the ocean or bay. Beach management zone was also important, with the highest probability of nest occurrence located within areas under species protection zones or closed to public use. Land use also returned a high permutation importance, with nests likely to be initiated on beaches, vegetated dunes, and mud flats. Total beach area within a 100-m radius was also important, with nesting areas consisting of 1.67 – 3.1 ha of surrounding beach. Distance to non-ocean tidal waters, elevation, and marsh area were less important predictors of nest occurrence, relative to those mentioned above. Slope was not an important predictor of nest occurrence relative to the remaining predictor variables. However, the Maxent response curves return the predicted probability of suitable conditions for the corresponding variable, disregarding all other variables (Phillips 2005). A probability of 0.5 indicates that a variable at that value predicts species' occurrence no better than random, while probabilities > 0.5 indicate the range of values of a given predictor variable that are correlated with species' presence. In our model, areas within 47 - 830 m of non-ocean tidal waters are associated with piping plover nest presence, reflecting the importance of non-ocean foraging areas, such as inlets, tidal ponds, and other low-energy shorelines. Elevation ranges of 0.3 – 3.5 m, a slope gradient of 1.75 to 21.3% grade, and nest locations in mudflats and overwash fans with less than 628 m^2 of surrounding marsh within 100-m radius also appears preferred.

Table 4. Maxent model results for the piping plover (*Charadrius melodus*)

Species and Model Variables[a]	*N*	AUC	Variable Permutation Importance
Piping Plover, *Charadrius melodus*	606	0.967	
distance to high tide line			33.6
management zone			21.8
land use			20.8
beach area within 100-m radius			16.9
dist. to non-ocean tidal waters			3.6
elevation			2.5
marsh area within 100-m radius			0.9
slope			0.0

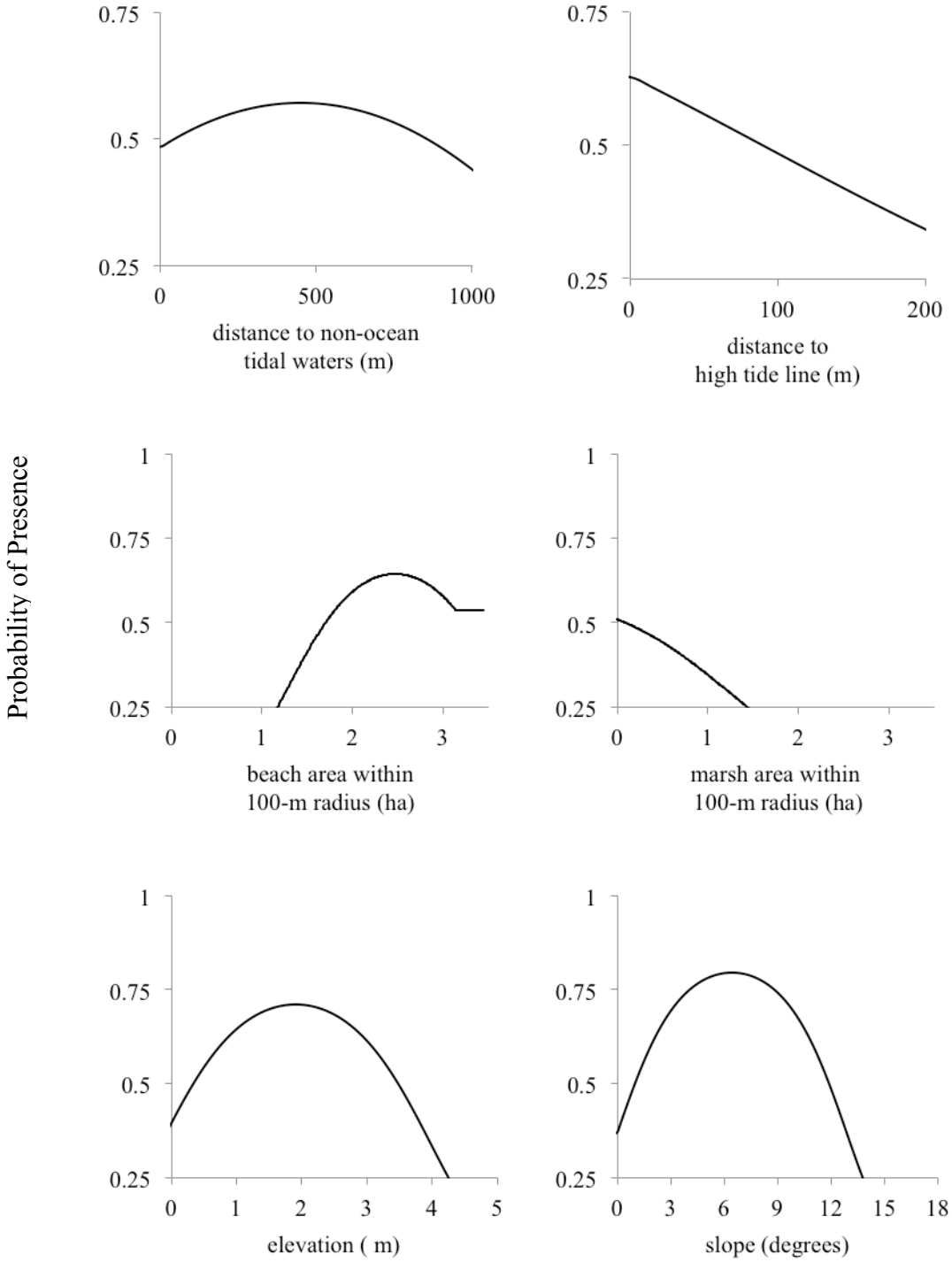

Figure 4. Response curves indicating the range of conditions correlated (probabilities > 0.5) with piping plover occurrence

5.2 Determination of Set-Aside Areas

For each management unit within the study area, the Maxent model assigns a probability of piping plover occurrence bounded by 0 and 1. We define management unit by the official property boundaries of municipal, state, or federally owned beaches. To identify areas within management units of higher potential for beach-nesting bird occupancy to set aside, we applied a suitability threshold of 0.5. This approach eliminates all potential beach-nesting bird areas with <50% probability of piping plover occupancy.

The model identifies ~1,611 ha of potential beach-nesting bird habitat across 66 management units within New Jersey (Appendix III). Of this total area, ~713 ha are currently managed for beach-nesting birds. During the breeding season, ~210 ha are closed to the public, ~339 ha are designated as species protection zones, and ~164 ha are classified as species precautionary zones. Thirty-two sites across New Jersey do not currently manage for beach-nesting birds, accounting for ~424 ha of potential habitat area. Twelve management units, Barnegat Light State Park, Forsythe NWR – Holgate, Tucker Island, Little Beach, North Brigantine Natural Area, Malibu Beach WMA, Strathmere Natural Area, Stone Harbor Point, US Coast Guard – LSU, USCG Training Center, Poverty Beach, and Cape May Meadows manage all the existing potential habitat within their jurisdiction. The remaining 20 sites manage between 15-96% of the total potential nesting habitat available (Figure 4). Maps of potential beach-nesting bird habitat across New Jersey are included in Appendix IV.

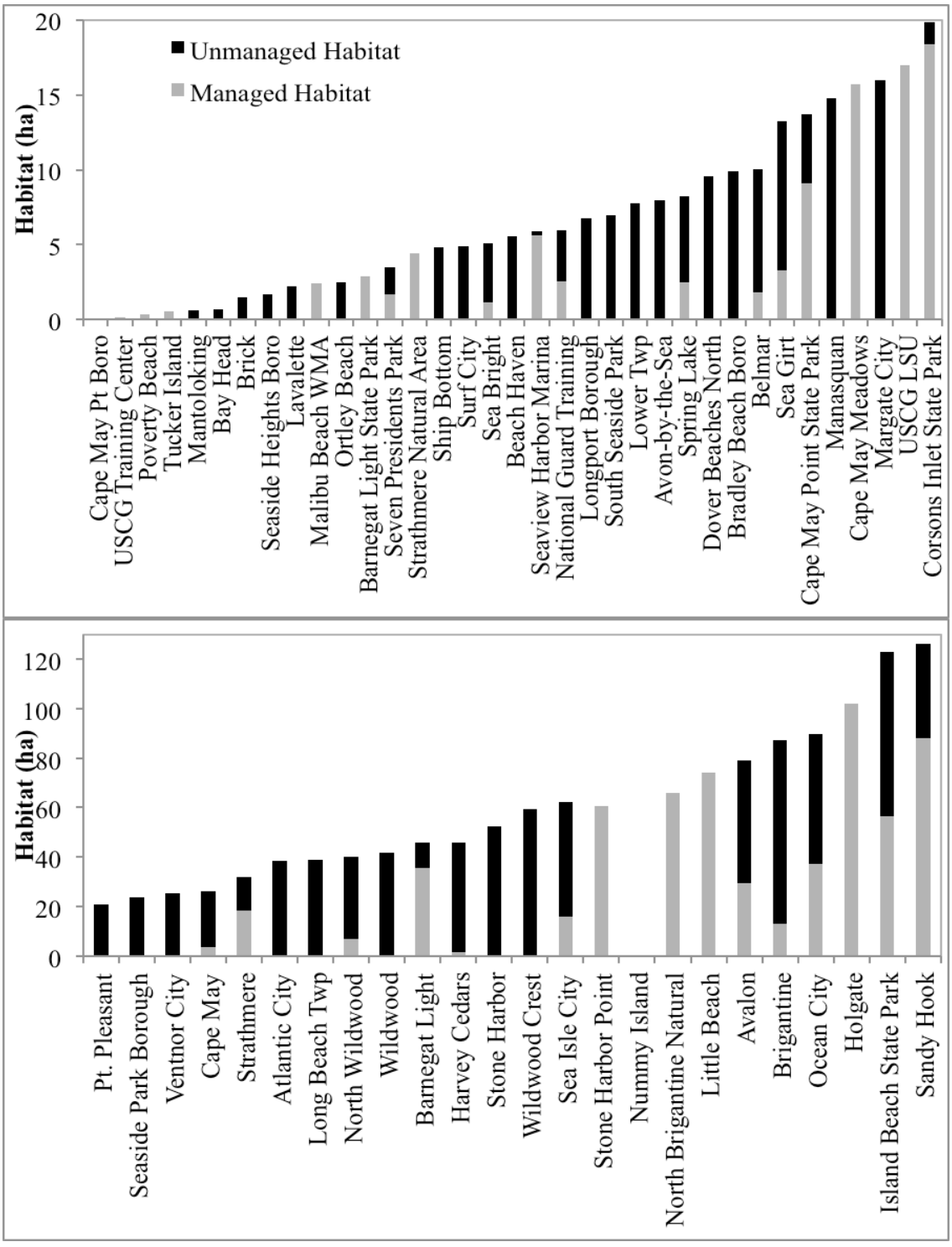

Figure 4. Managed and unmanaged potential beach-nesting bird habitat area in New Jersey. Managed areas include closed sections of beach, species protection zones, and species precautionary zones.

6.0 MANAGEMENT RECOMMENDATIONS FOR BEACH-NESTING BIRD SET-ASIDE AREAS

The majority of currently unmanaged areas identified as potential beach-nesting bird habitat returned suitability scores of 0.5 – 0.6. Because these areas are still being managed for recreational purposes, they likely lack the microhabitat features important in nest-site selection. However, based on the link between beach-nesting bird management regulations and beach successional dynamics, we fully expect these areas to increase in suitability over time if set-aside for beach-nesting birds. To maximize occupancy potential, we recommend the following management provisions for set-aside areas:

1. *Designate set-aside areas as species protection zones*: Implementation of management may not result in immediate occupancy by beach-nesting birds. Individuals typically return to previous breeding sites early in the season. Post-breeding individuals and juveniles then investigate new breeding sites after the breeding season in late summer/early fall. Species protection zones would protect these sites from human disturbance during this period.

2. *Maintain protective measures year-round*: As discussed above, eliminating raking, pedestrians, and vehicles from a portion of the beach allows beach successional dynamics to occur. Over time, habitat suitability will increase due to the formation of microhabitat features important in nest-site selection (i.e. incipient dunes, shell substrate, sparse vegetation growth).

3. *Prohibit installation of beach stabilization features*: Sand fencing and dense dune grass plantings promote the capture of sand and the formation of dunes. However, this practice speeds the normal rate of succession, resulting in larger, densely vegetated dunes that eliminate nesting habitat and encourage occupancy by mammalian nest predators (Maslo et al. 2011, Nordstrom 2005). Areas set aside for beach-nesting birds should be allowed to evolve via natural processes.

4. *Consider predator management in newly set-aside areas*: The results of the habitat suitability models used in this report use landscape characteristics to assess the probability of beach-nesting bird occurrence. However, additional factors contribute to the overall suitability of a given site, including the predator community. Prior to establishing a set-aside area, an assessment of the predator community by a wildlife biologist should be conducted. Focal predators include (but are not limited to): red foxes (*Vulpes vulpes*), feral and free-ranging cats (*Felis catus*), gulls (*Larus* spp.), and crows (*Corvus* spp.). If these or other predators pose a substantial threat to nesting birds, predator management should be considered.

5. *Provide flexibility in yearly set-aside designations:* The recommendations provided here are based upon a predictive model of suitable habitat generated from environmental GIS data. It is important to recognize that beaches are highly dynamic systems; morphology and other conditions can change substantially from severe storms and elevated tide levels. At this time, currently established beach management plans define static locations to be

set-aside for beach-nesting birds. We recommend that the boundaries of protection zones be flexible to accommodate changes to morphological conditions. Set-aside areas should be agreed upon by landowners and regulatory agencies at the start of each breeding season prior to the arrival of birds.

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APPENDIX I

Appendix I. Land use types across the coastal zone of New Jersey, USA.

Land Use Types
Agriculture
Atlantic Ocean
Bare Exposed Rock, Rock Slides, Etc.
Barren Land
Beaches
Dredged Lagoon
Forest/Woodland
Green Space
Lakes
Managed Wetland In Built-Up, Maintained
Recreational Area
Mud Flat
Open Tidal Bays
Other Wetlands
Phragmites
Residential
Roads And Rails
Saline Marsh (High Marsh)
Saline Marsh (Low Marsh)
Scrub/Shrubland
Streams And Canals
Tidal Pond
Tidal Rivers, Inland Bays, And Other Tidal Waters
Urban/Built-Up Land
Vegetated Dune Communities

(Source: New Jersey Department of Environmental Protection, 2007)

APPENDIX II

APPENDIX II – Detailed information on source data used in species distribution models

Title:
USDA-FSA-APFO NAIP MrSID Mosaic, 2010
Publication Date:
2010-08-10
Originator:
USDA-FSA Aerial Photography Field Office
Online Linkage:
https://njgin.state.nj.us/NJ_NJGINExplorer/ShowMetadata.jsp?docId=EEA7E13A-45BC-11E0-92E0-0003BA02A824
Dataset Credit:
U.S. Department of Agriculture, Service Center Agencies

Title:
Coastline of New Jersey, Edition 20150501 (Land_coastline_2012)
Publication Date:
2015-05-01
Originator:
NJ Department of Environmental Protection (NJDEP), Bureau of Geographic Information System (BGIS)
Online Linkage:
http://www.state.nj.us/dep/gis/digidownload/zips/statewide/coast_2012.zip
Dataset Credit:
NJ Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information System (BGIS)

Title:
Hurricane Sandy: Rapid Response Imagery of the Surrounding Regions
Publication Date:
2012-10-31
Originator:
Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), National Geodetic Survey (NGS), Remote Sensing Division
Online Linkage:
http://storms.ngs.noaa.gov/storms/sandy/
Dataset Credit:

National Oceanic and Atmospheric Administration (NOAA)

Title:

Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index

Publication Date:

2014

Originator:

National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, Hazardous Materials Response Division, Seattle, Washington ,and States of Delaware, New Jersey, and Pennsylvania

Online Linkage:

http://response.restoration.noaa.gov/maps-and-spatial-data/download-esi-maps-and-gis-data.html

Dataset Credit:

This project was supported by the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Office of Response and Restoration, Hazardous Materials Response Division, Seattle, Washington, and the States of Delaware, New Jersey, and Pennsylvania

---

Title:

NJDEP 2007 Land use/Land cover

Publication Date:

2010-05-25

Originator:

NJ Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information System (BGIS)

Online Linkage:

http://www.nj.gov/dep/gis/lulc07cshp.html

Dataset Credit:

NJ Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information System (BGIS)

Title:

NJDEP 10-meter Digital Elevation Grid

Publication Date:

2002-06-01

Originator:

NJ Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA)

Online Linkage:

http://www.nj.gov/dep/gis/wmalattice.html

Dataset Credit:

Original source 1:24,000 (10-meter) DEM's were purchased from USGS. This grid data set was produced by the NJ Department of Environmental Protection, Bureau of Geographic Information and Analysis.

Title:

EAARL Coastal Topography – New Jersey Coast, Post-Hurricane Sandy, 2012-DRAFT

Publication Date:

Unpublished material

Originator:

U.S. Geological Survey

Dataset Credit:

U.S. Geological Survey, St. Petersburg Coastal and Marine Science Center

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Title:

Management Plan Designations for Beach-Nesting Birds in New Jersey

Publication Date:

Unpublished material

Originator:

NJ Department of Environmental Protection, NJ Division of Fish and Wildlife Endangered and Nongame Species Program

Dataset Credit:

NJ Department of Environmental Protection, NJ Division of Fish and Wildlife Endangered and Nongame Species Program

APPENDIX III

Appendix III: Managed and unmanaged potential piping plover habitat across New Jersey.

Location	Managed[1] Habitat (ha)	Unmanaged Habitat (ha)	Total (ha)
Sandy Hook	88.4	37.4	125.8
Sea Bright	0.72	3.72	4.44
Monmouth Beach	0.00	0.00	0.00
Seven Presidents Park	1.48	1.61	3.09
Long Branch	0.00	0.00	0.00
Deal Borough	0.00	0.00	0.00
Allenhurst Borough	0.00	0.00	0.00
Loch Arbour	0.00	0.00	0.00
Asbury Park	0.00	0.00	0.00
Neptune Township	0.00	0.00	0.00
Bradley Beach Borough	0.00	7.78	7.78
Avon-by-the-Sea	0.00	8.12	8.12
Belmar	1.78	7.53	9.31
Spring Lake	2.51	5.33	7.84
Sea Girt	3.39	9.02	12.4
National Guard Training Center	2.53	3.27	5.80
Manasquan	0.00	14.3	14.3
Pt. Pleasant	0.00	20.3	20.3
Bay Head	0.00	0.58	0.58
Mantoloking	0.00	0.58	0.58
Brick	0.00	1.46	1.46
Dover Beaches North	0.00	9.07	9.07
Lavalette	0.00	2.35	2.35
Ortley Beach	0.00	2.38	2.38
Seaside Heights Borough	0.00	2.14	2.14
Seaside Park Borough	0.00	23.6	23.6
South Seaside Park	0.00	6.32	6.32
Island Beach State Park	56.2	64.1	120.3
Barnegat Light State Park	2.83	0.00	2.83
Barnegat Light	36.0	10.1	46.1
Long Beach Township	0.00	37.1	37.1
Harvey Cedars	1.66	44.9	46.6
Surf City	0.00	4.70	4.70
Ship Bottom	0.00	4.07	4.07
Beach Haven	0.00	5.50	5.50
Forsythe NWR - Holgate	115.3	0.00	115.3

Tucker Island	0.53	0.00	0.53
Little Beach	75.8	0.00	75.8
North Brigantine Natural Area	64.8	0.00	64.8
Brigantine	14.0	74.5	88.5
Atlantic City	0.00	38.9	38.9
Ventnor City	0.00	25.2	25.2
Margate City	0.00	15.4	15.4
Longport Borough	0.00	5.73	5.73
Seaview Harbor Marina	5.80	0.21	6.01
Malibu Beach WMA	2.09	0.00	2.09
Ocean City	37.5	48.1	85.6
Corsons Inlet State Park	18.7	1.34	20.0
Strathmere Natural Area	4.32	0.00	4.32
Strathmere	18.4	13.0	31.4
Sea Isle City	15.7	44.3	60.0
Avalon	29.8	48.8	78.6
Stone Harbor	0.00	52.6	52.6
Stone Harbor Point	61.4	0.00	61.4
*Nummy Island	0.00	0.49	0.49
North Wildwood	7.84	29.8	37.6
Wildwood	0.00	65.6	65.6
Wildwood Crest	0.00	62.7	62.7
Lower Township	0.00	7.76	7.76
USCG LSU	15.9	0.00	15.9
USCG Training Center	0.14	0.00	0.14
Poverty Beach	0.27	0.00	0.27
Cape May	3.68	21.2	24.8
Cape May Meadows	15.4	0.00	15.4
Cape May Point State Park	8.98	4.64	13.62
Cape May Point Borough	0.00	0.00	0.00
TOTAL	**713.9**	**897.6**	**1,611.3**

[1]Managed habitat includes areas closed to the public during the breeding season, areas designated as species protection zones, and areas designated as species precautionary zones.

APPENDIX IV

POTENTIAL BEACH-NESTING BIRD HABITAT: SANDY HOOK

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 250 500 1,000

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SANDY HOOK - NORTH

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 260 520 1,040

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

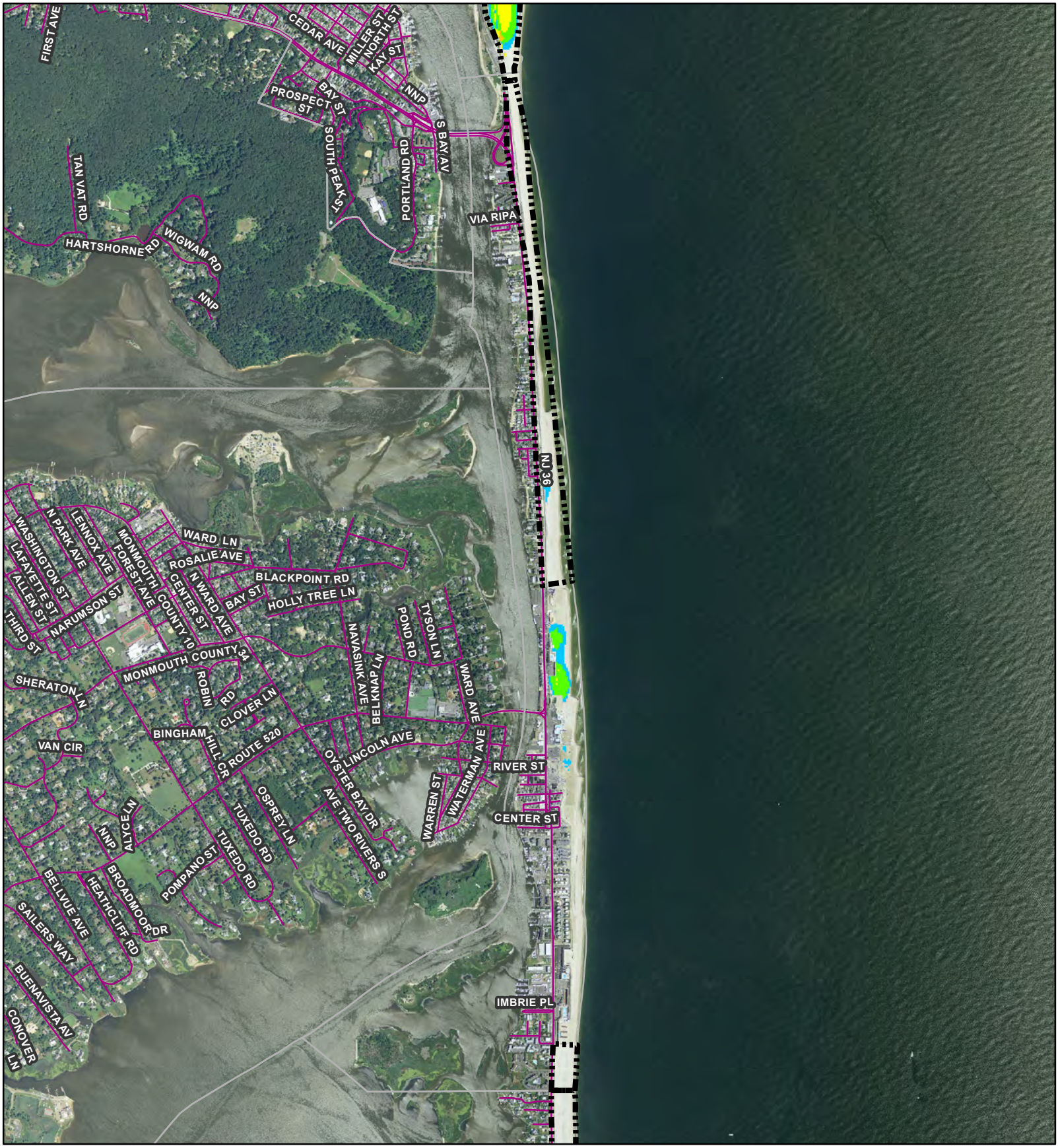
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SANDY HOOK - SOUTH

RUTGERS



Meters
0 280 560 1,120

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEA BRIGHT

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

0 155 310 620 Meters

N W E S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEA BRIGHT - DETAIL

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 120 240 480

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

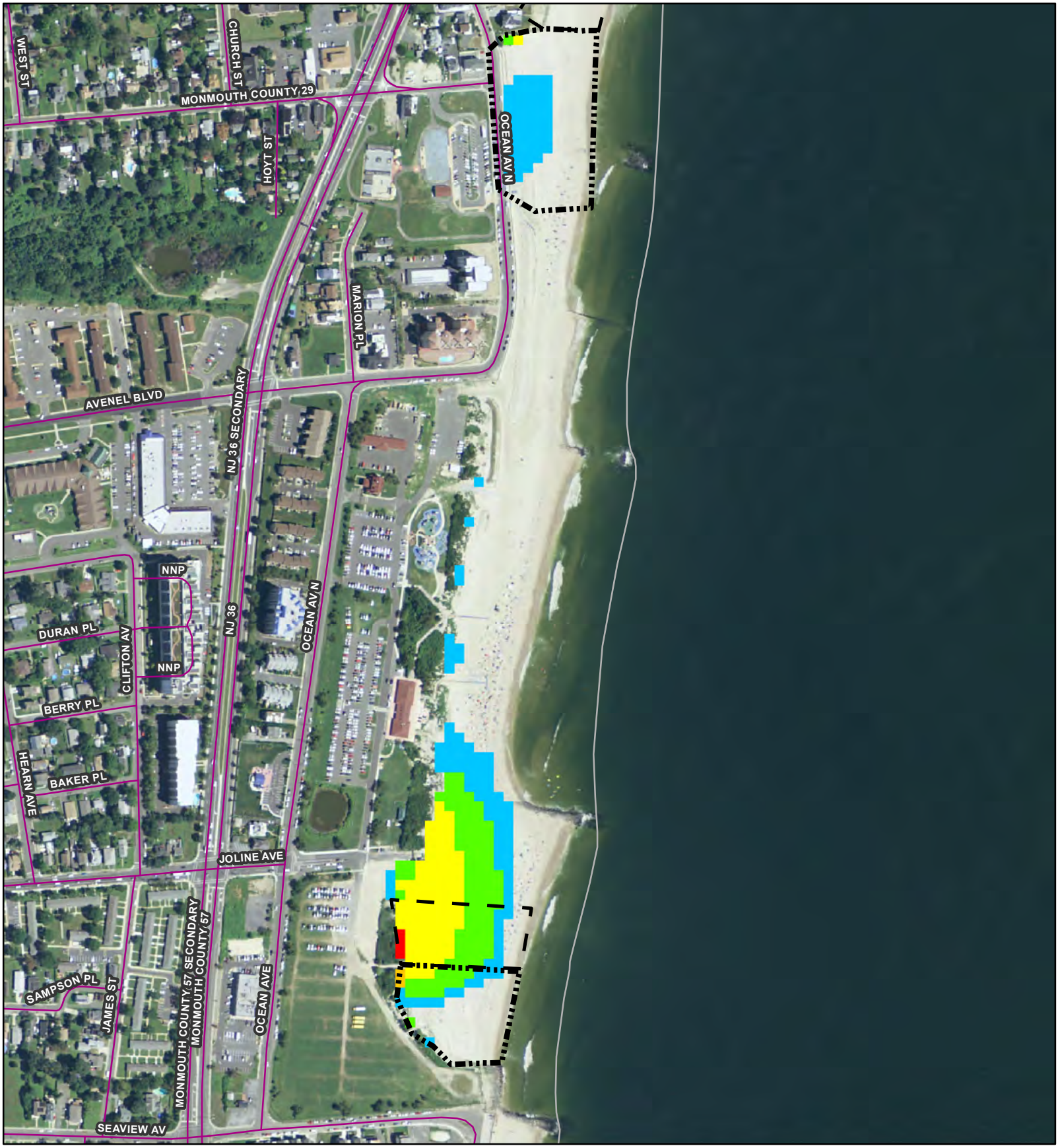
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: MONMOUTH BEACH

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 45 90 180

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEVEN PRESIDENTS PARK

RUTGERS

Meters
0 65 130 260

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

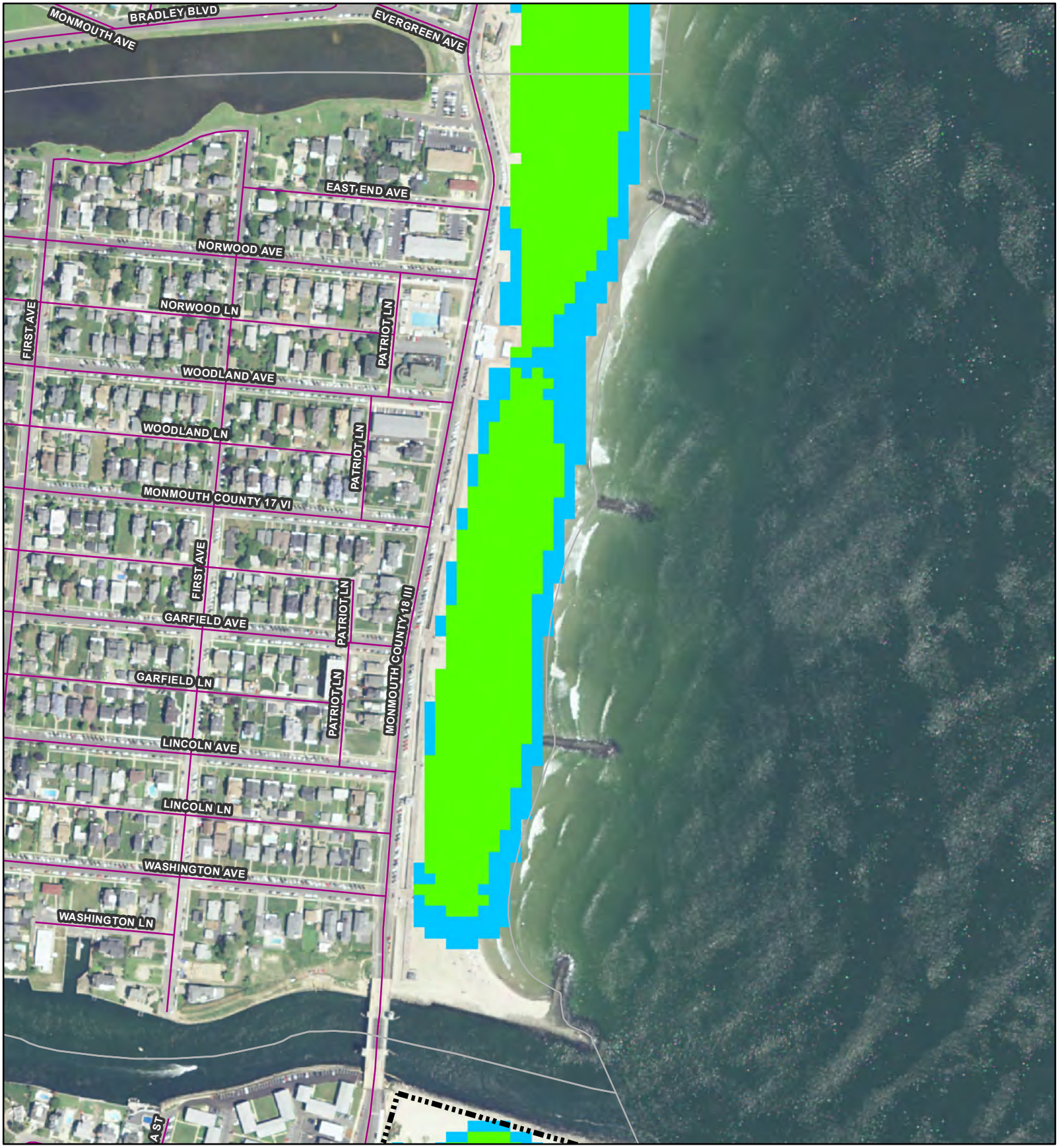
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: BRADLEY BEACH BORO

RUTGERS



Meters
0 40 80 160

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: AVON-BY-THE-SEA

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

0 105 210 420 Meters

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

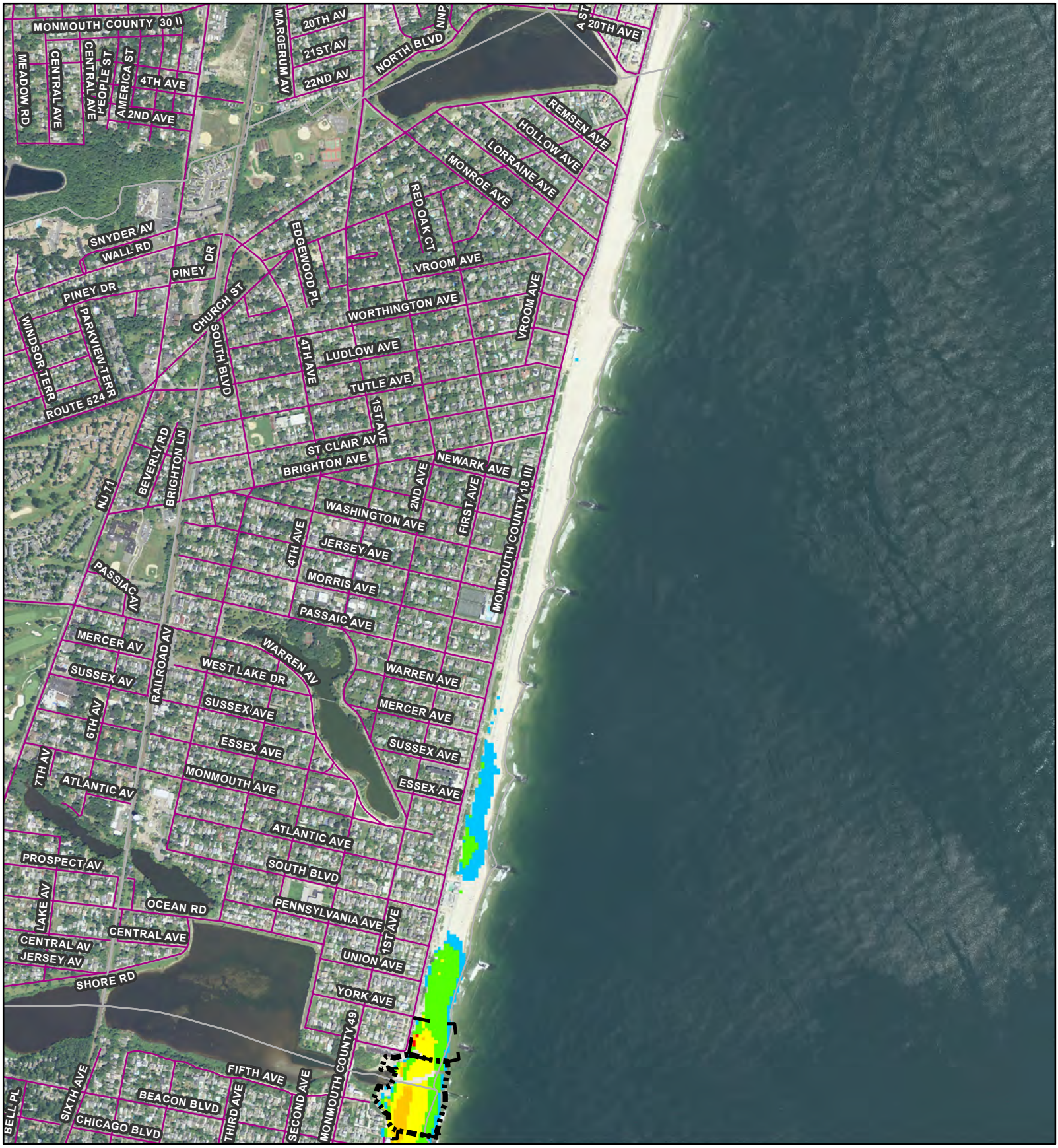
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: BELMAR

RUTGERS



Meters
0 150 300 600

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SPRING LAKE

RUTGERS

Meters
0 110 220 440

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEA GIRT & NATIONAL GUARD TRAINING CENTER

RUTGERS

0 90 180 360 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

- Precautionary
- Protection
- Closed

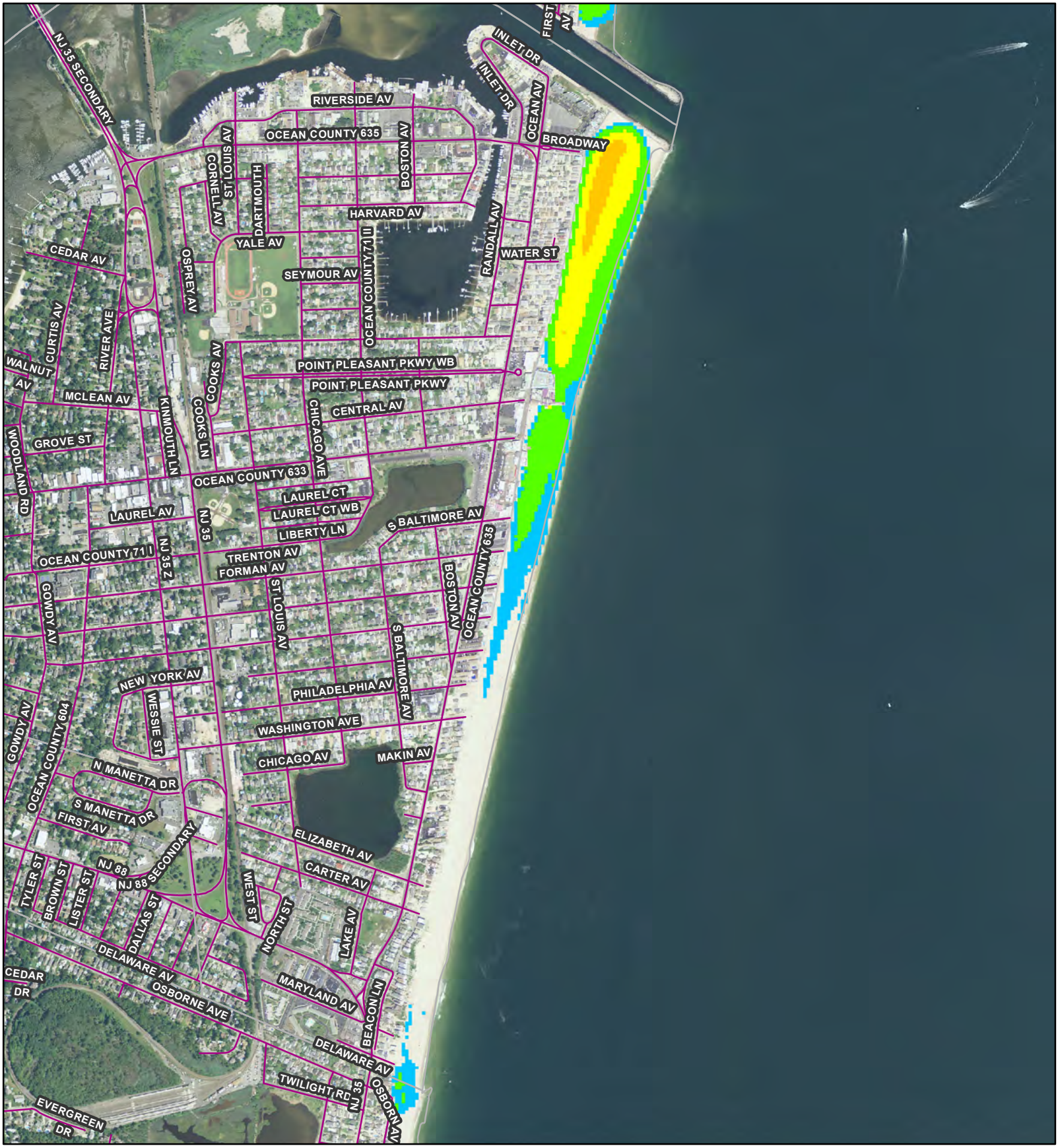
Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: MANASQUAN

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



0 140 280 560 Meters

N W E S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

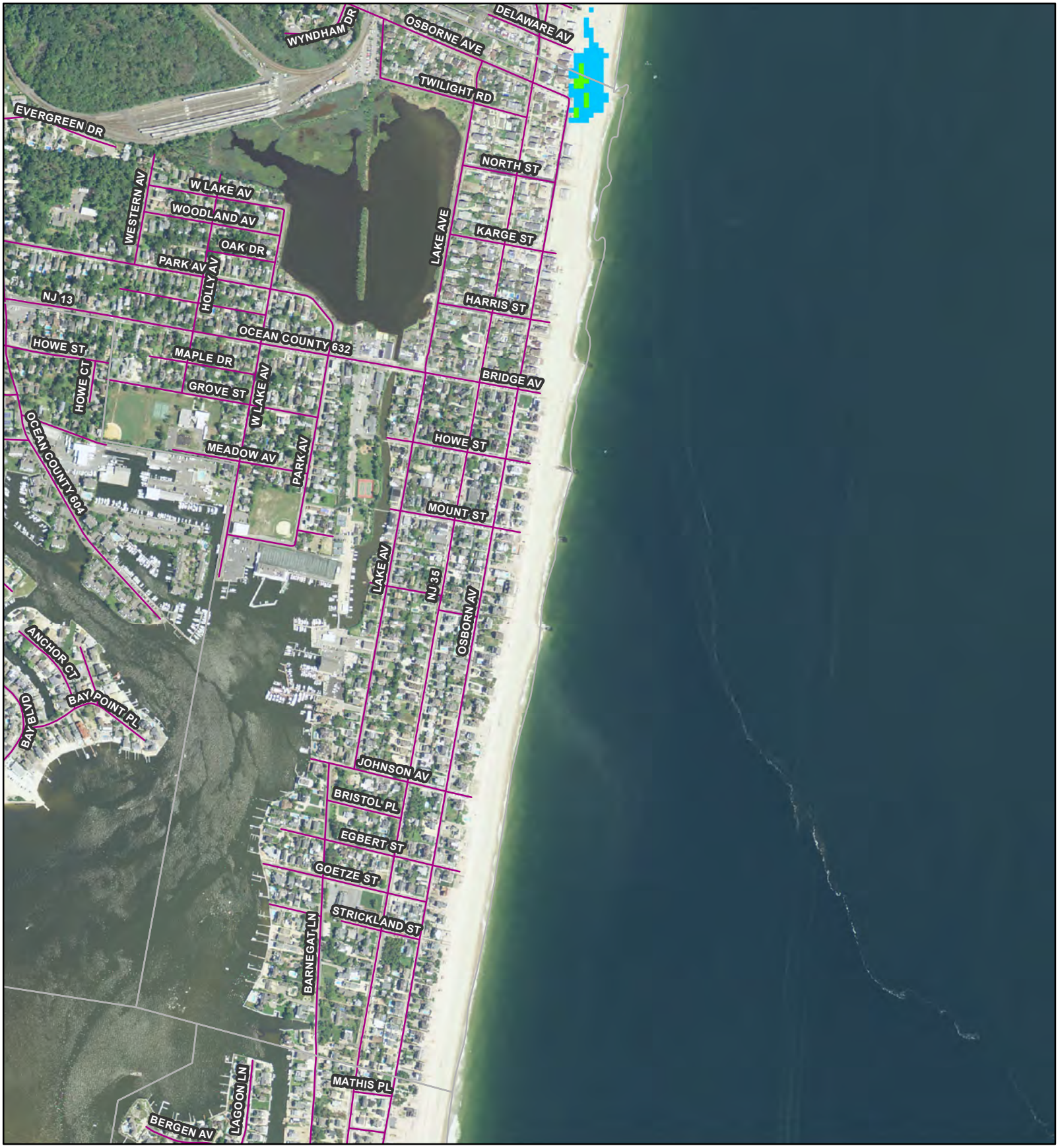
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: PT. PLEASANT

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 95 190 380

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

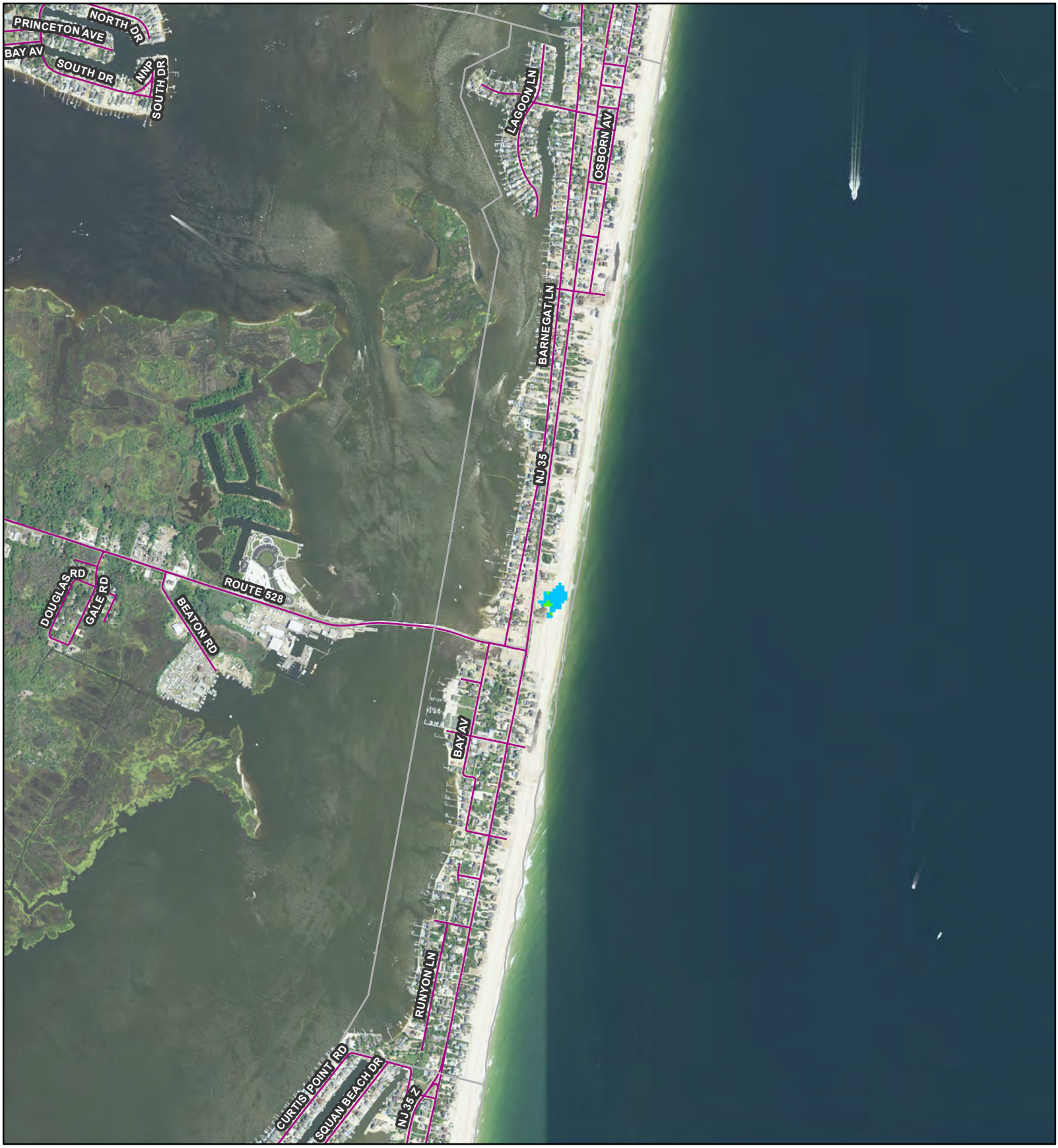
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: BAY HEAD

RUTGERS



0 162.5 325 650 Meters

N W E S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

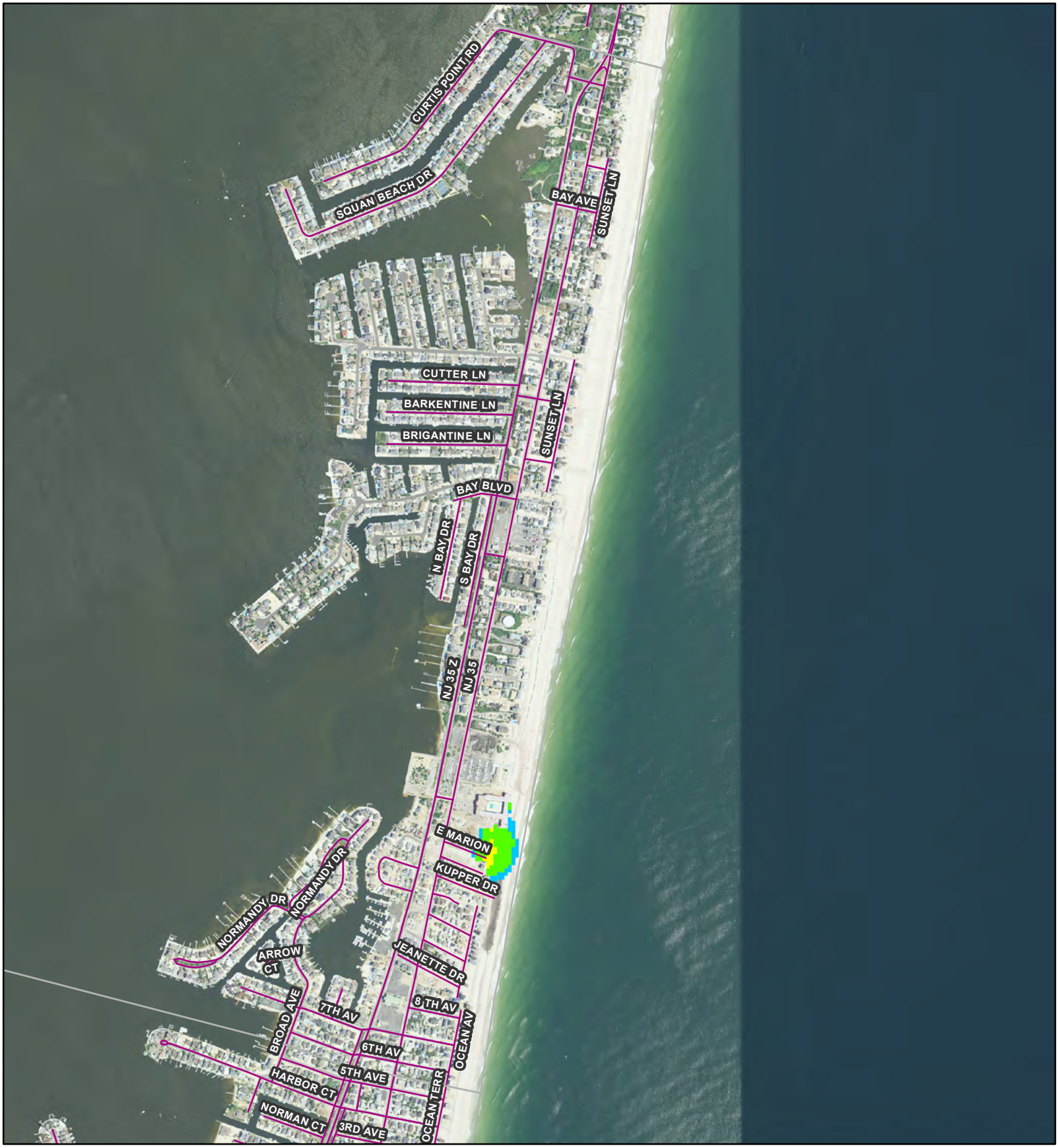
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: MANTOLOKING

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 130 260 520

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

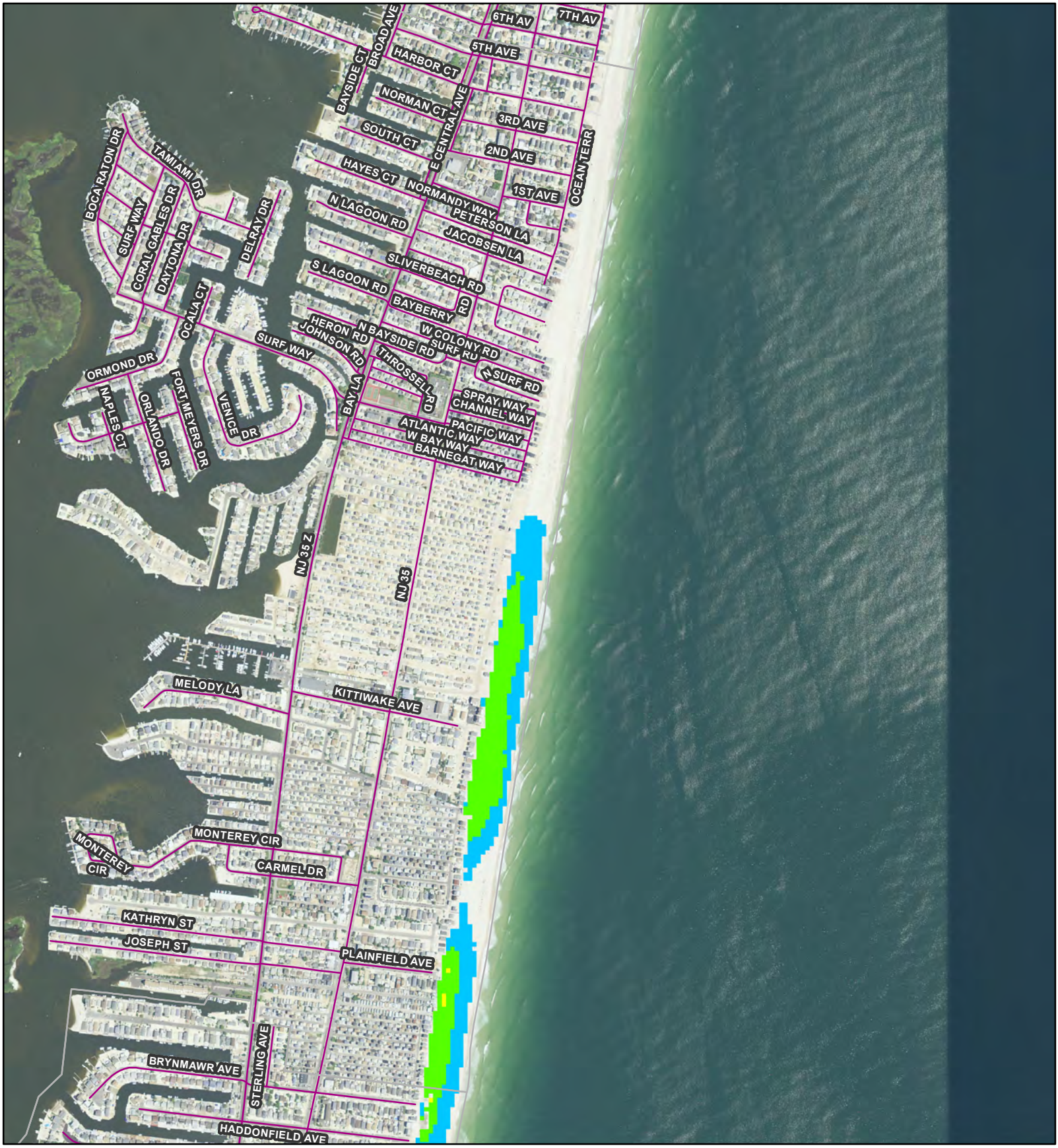
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: BRICK

RUTGERS



0 110 220 440 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

- Precautionary
- Protection
- Closed

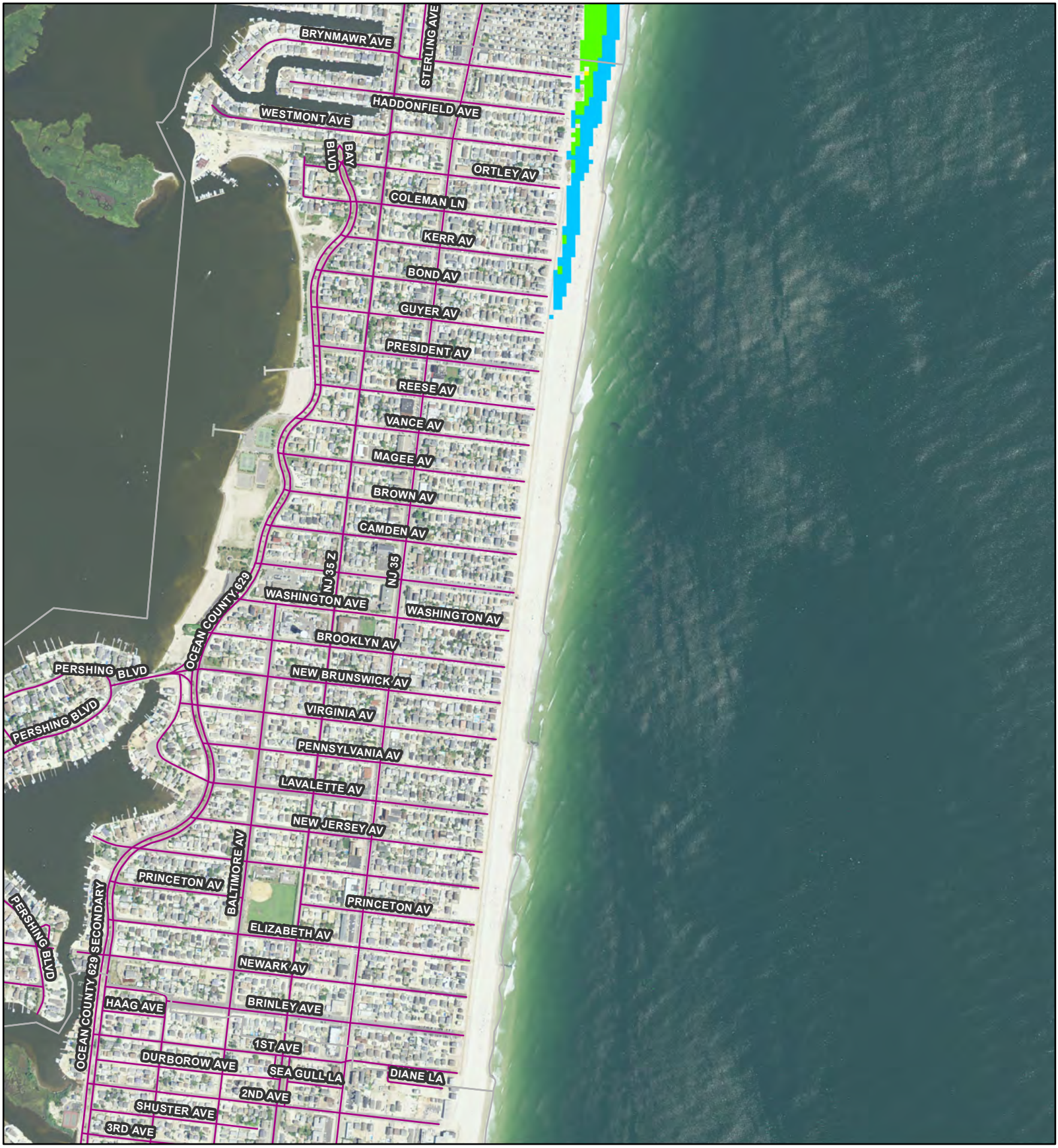
Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: DOVER BEACHES NORTH

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 105 210 420

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

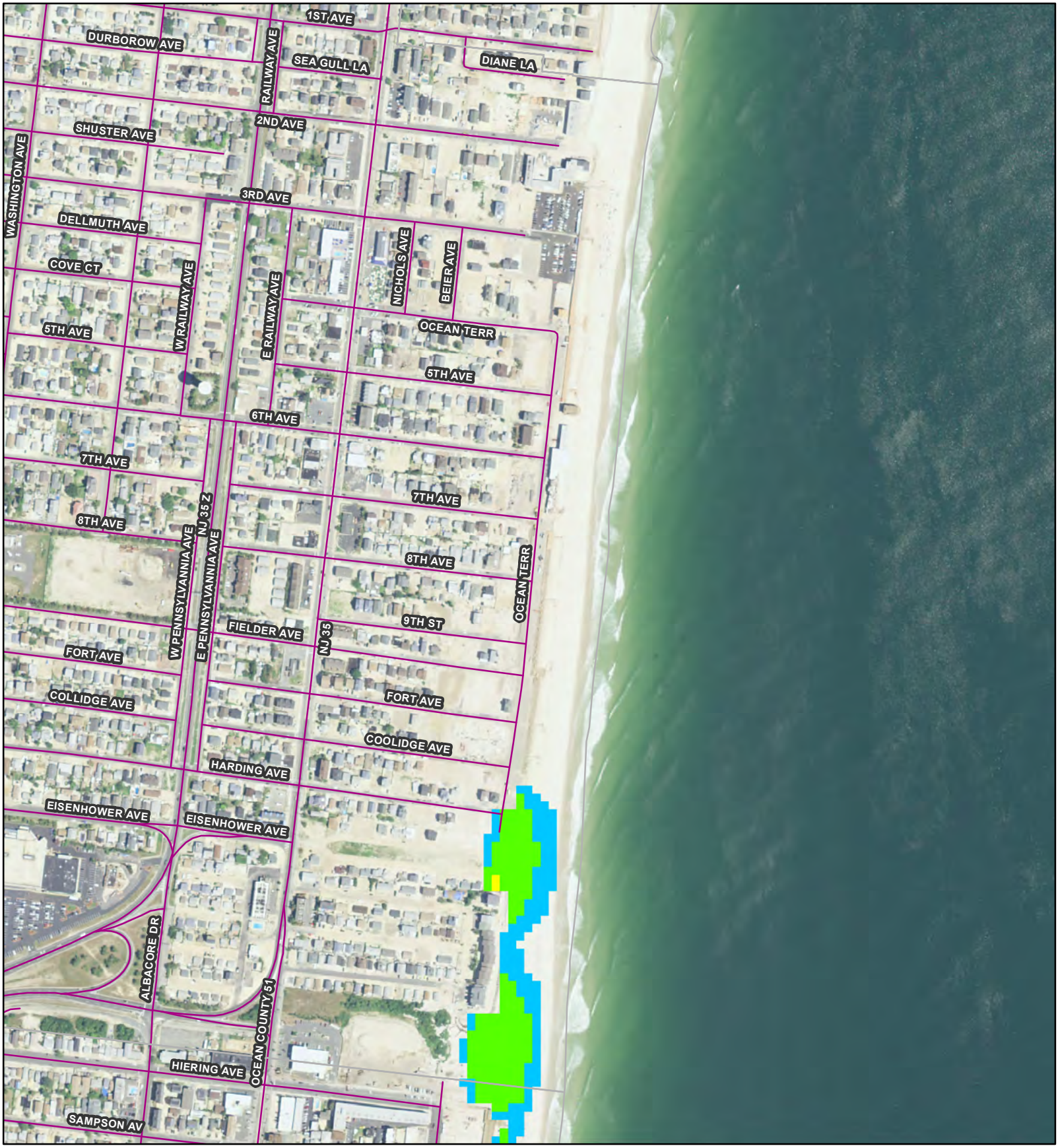
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: LAVALETTE

RUTGERS



Meters
0 55 110 220

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

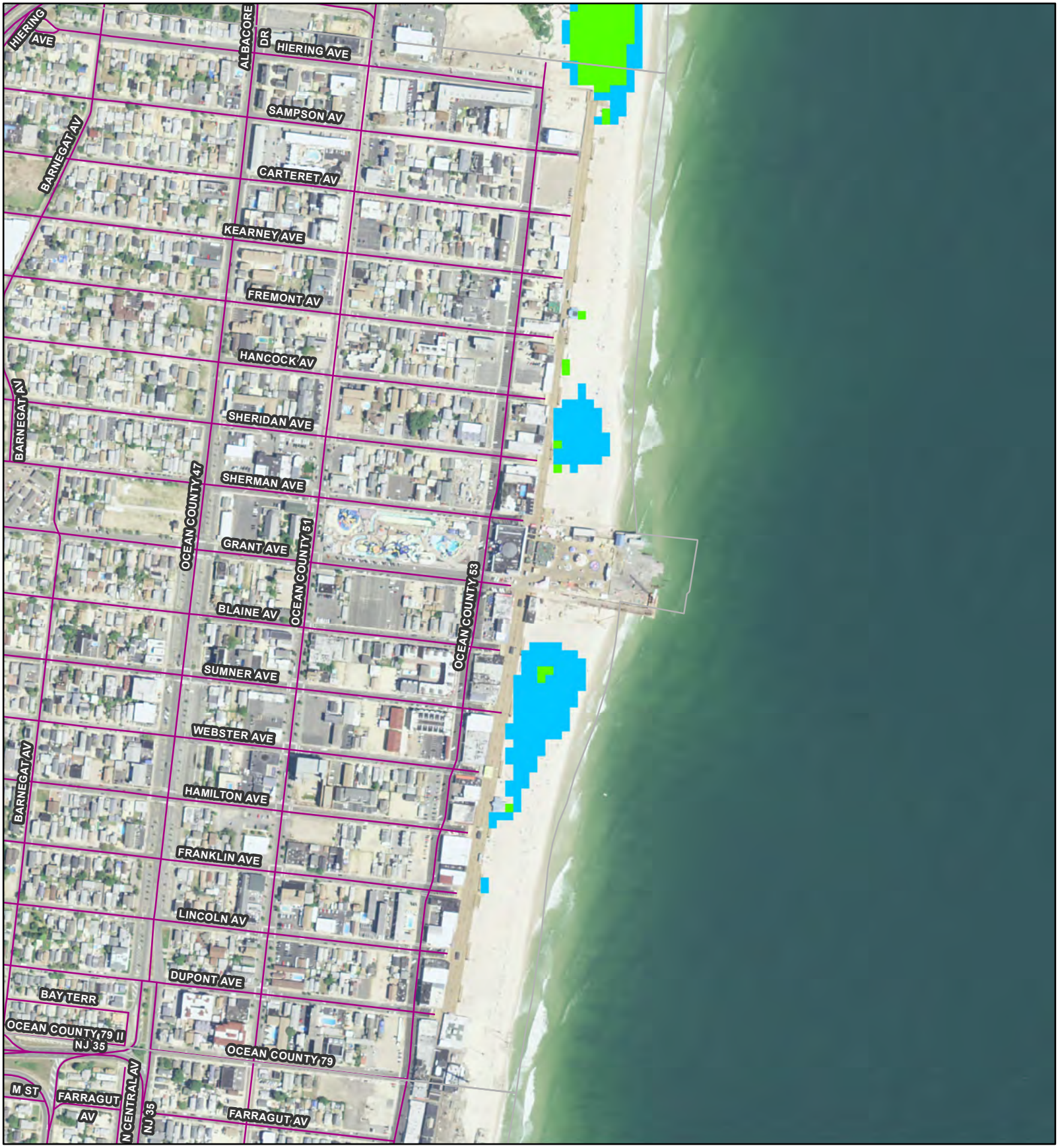
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: ORTLEY BEACH

RUTGERS



Meters
0 55 110 220

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEASIDE HEIGHTS BORO

RUTGERS

0 125 250 500 Meters

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

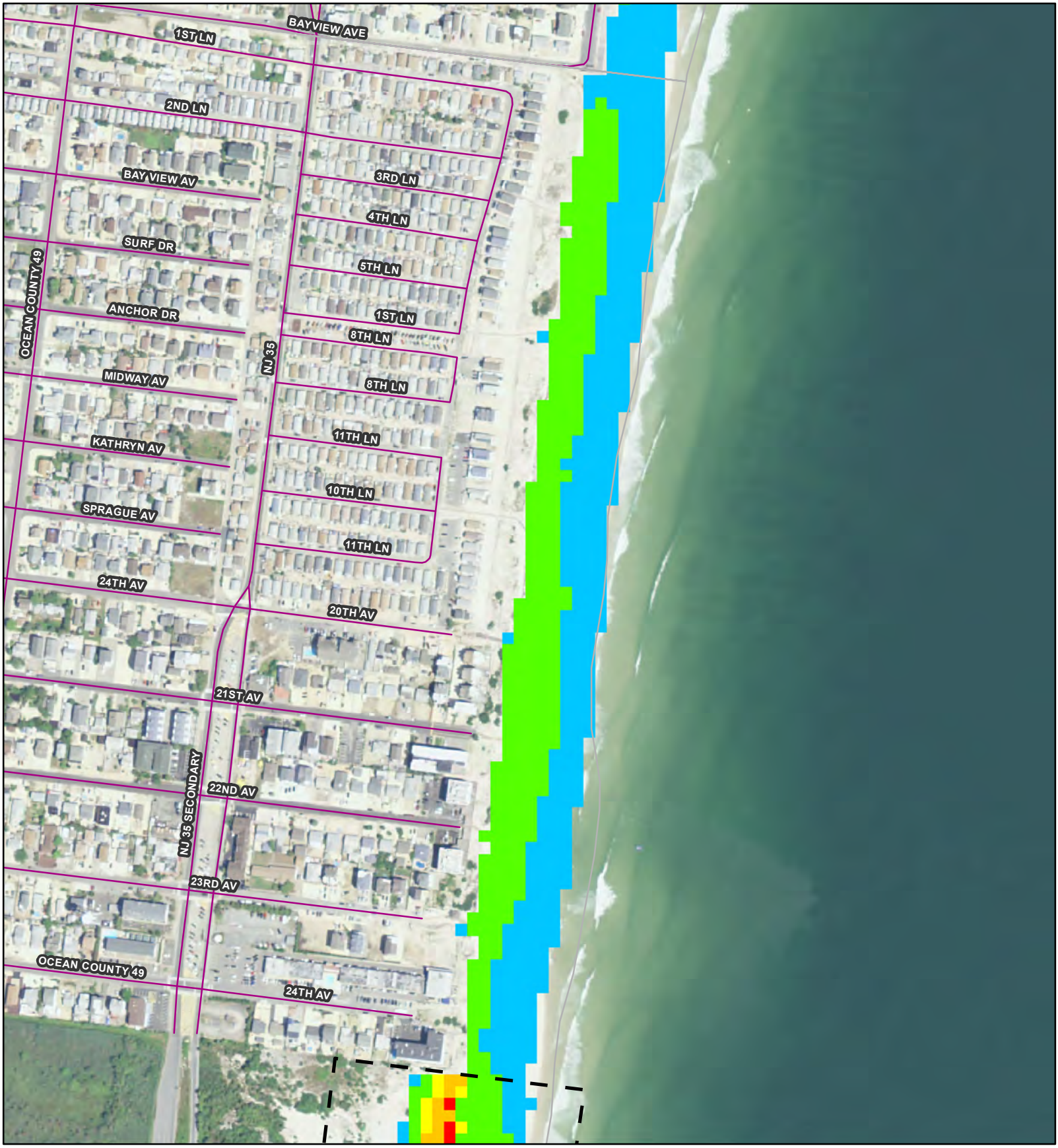
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEASIDE PARK BOROUGH

RUTGERS



0 40 80 160 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

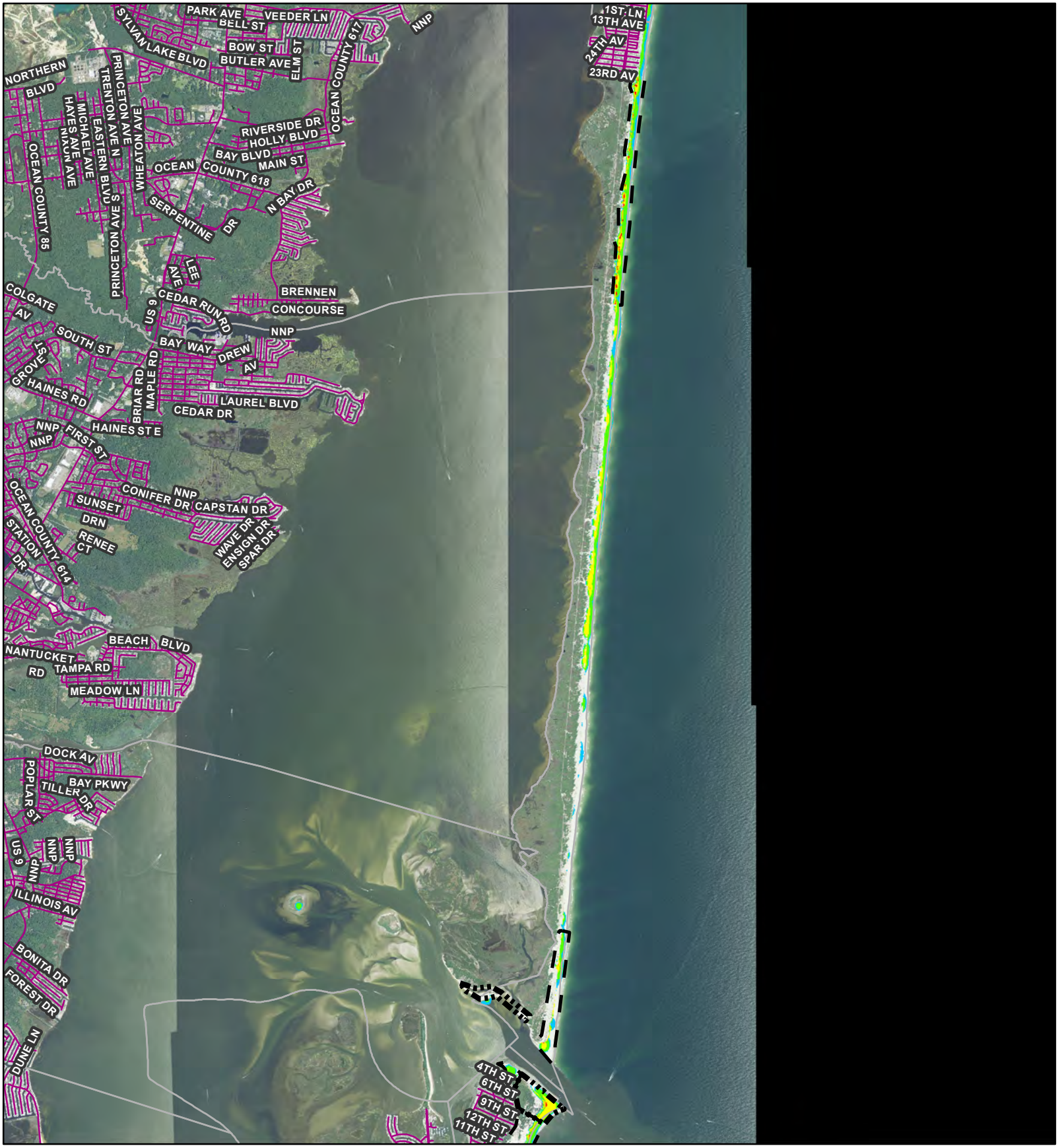
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SOUTH SEASIDE PARK

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters

0 750 1,500 3,000

N

W E

S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

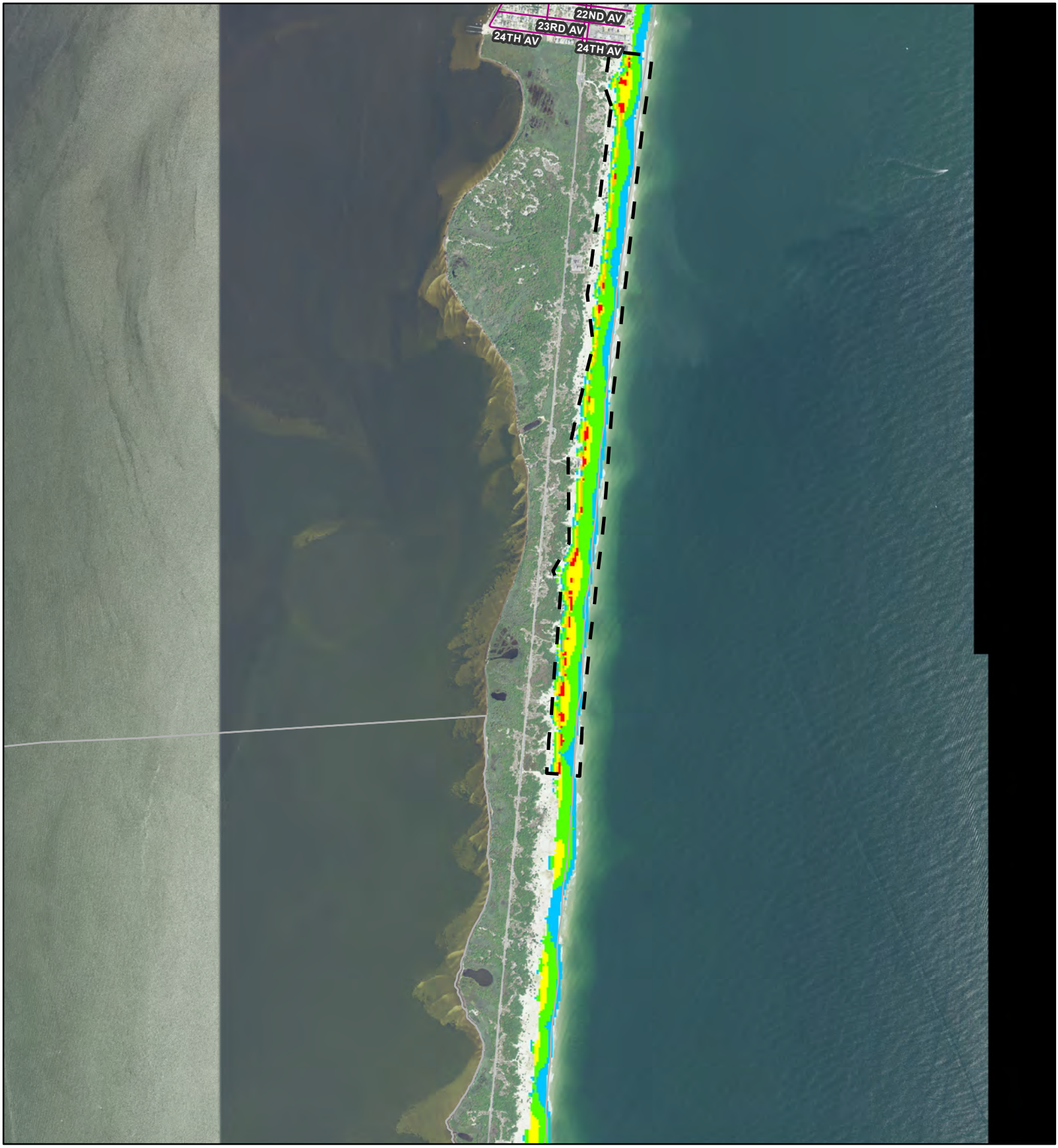
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: ISLAND BEACH STATE PARK

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 240 480 960

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

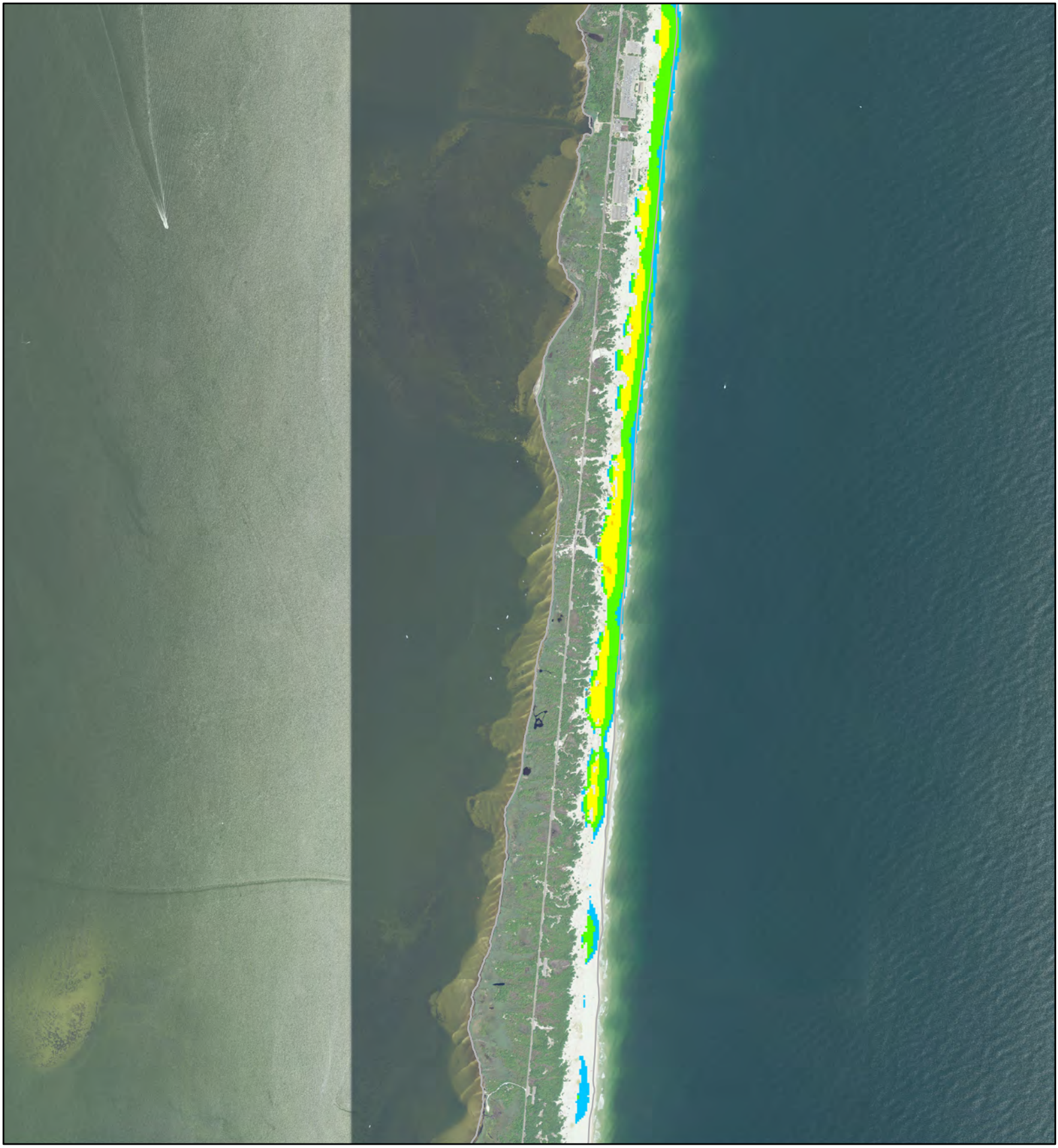
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: ISLAND BEACH STATE PARK - NORTH

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



0 240 480 960 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

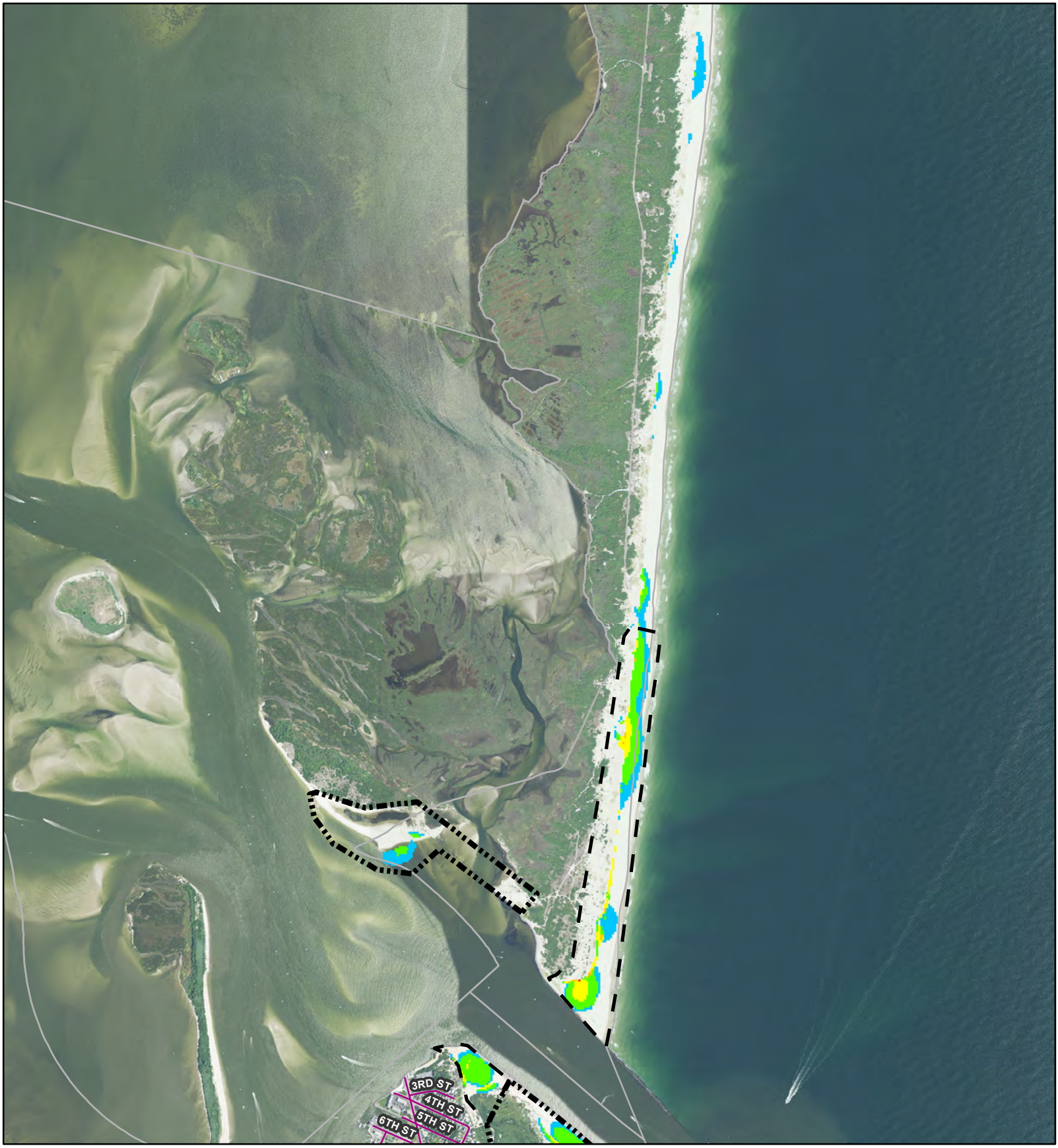
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: ISLAND BEACH STATE PARK - CENTRAL

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



POTENTIAL BEACH-NESTING BIRD HABITAT: ISLAND BEACH STATE PARK - SOUTH

0 240 480 960 Meters

N W E S

Municipal boundary

Roadways

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

0 140 280 560 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: BARNEGAT LIGHT STATE PARK & BARNEGAT LIGHT

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

POTENTIAL BEACH-NESTING BIRD HABITAT: LONG BEACH TWP - LOVELADIES

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 140 280 560

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: HARVEY CEDARS

RUTGERS

Meters
0 90 180 360

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: LONG BEACH TWP - NORTH BEACH

RUTGERS

0 95 190 380 Meters

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

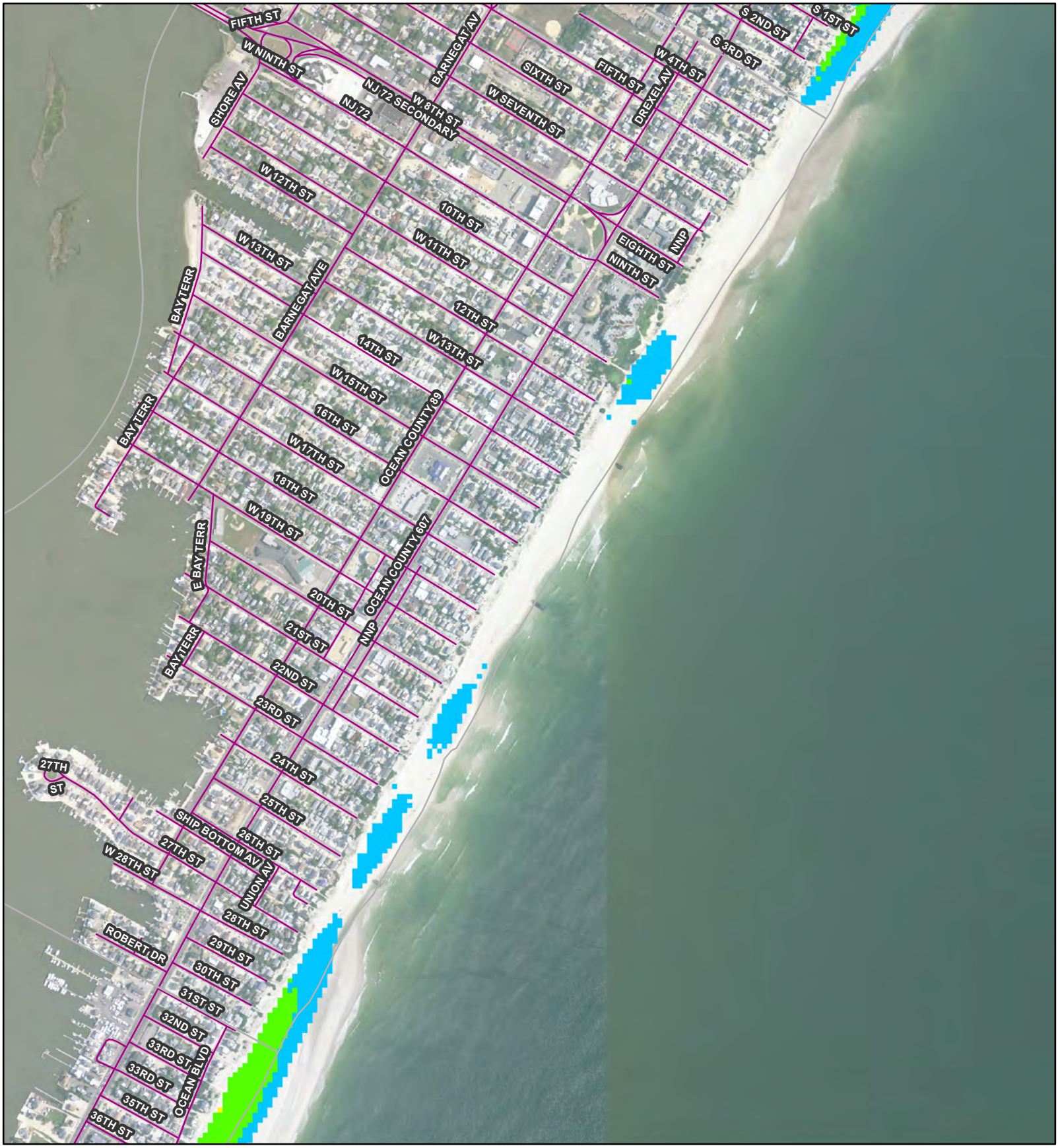
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SURF CITY

RUTGERS



Meters
0 95 190 380

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SHIP BOTTOM

RUTGERS

0 75 150 300 Meters

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: LONG BEACH TWP - BRANT BEACH, BEACH HAVEN CREST

RUTGERS

0 125 250 500 Meters

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: BEACH HAVEN

RUTGERS

0 90 180 360 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

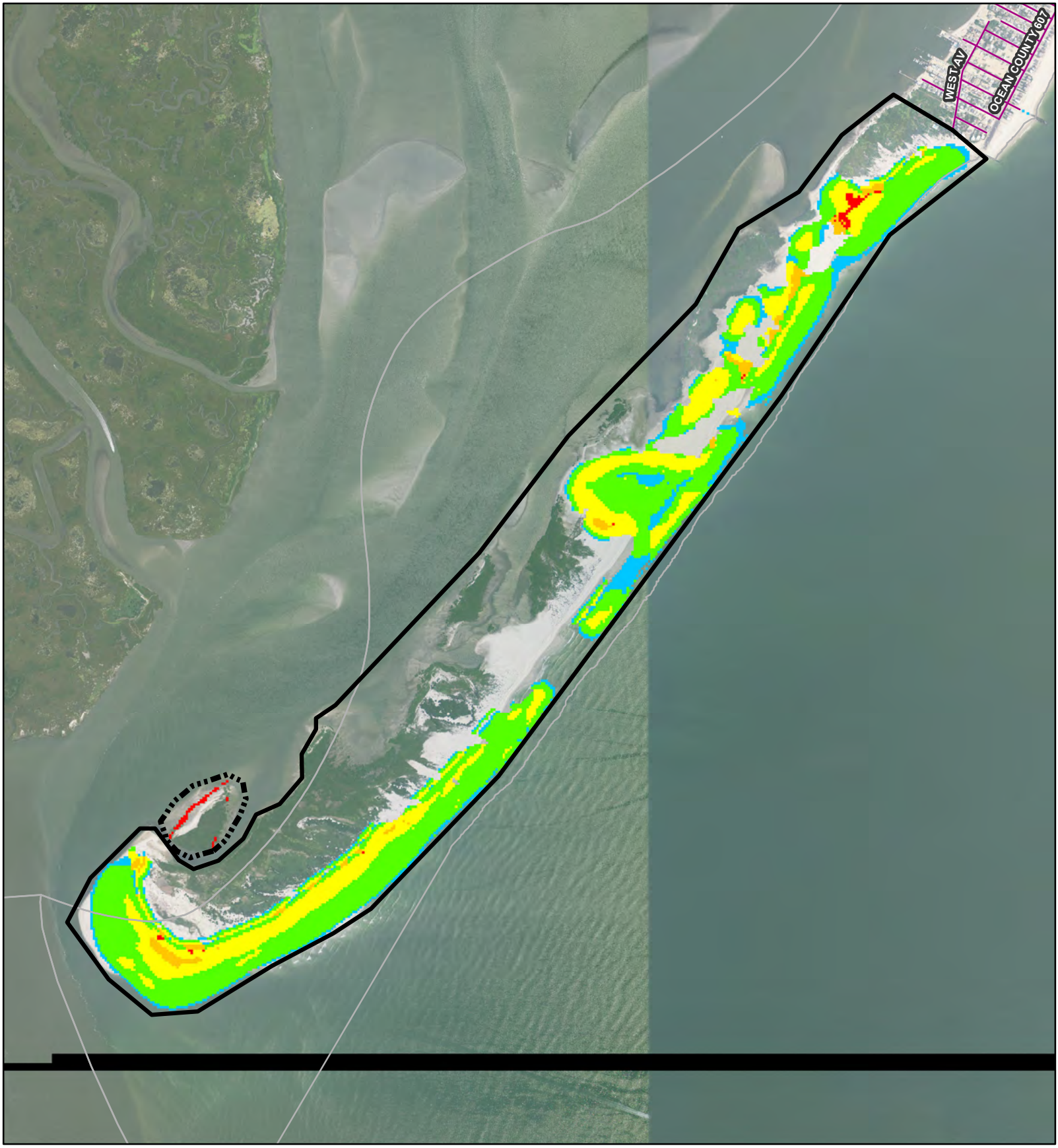
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: LONG BEACH TWP - HOLGATE

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



0 200 400 800 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

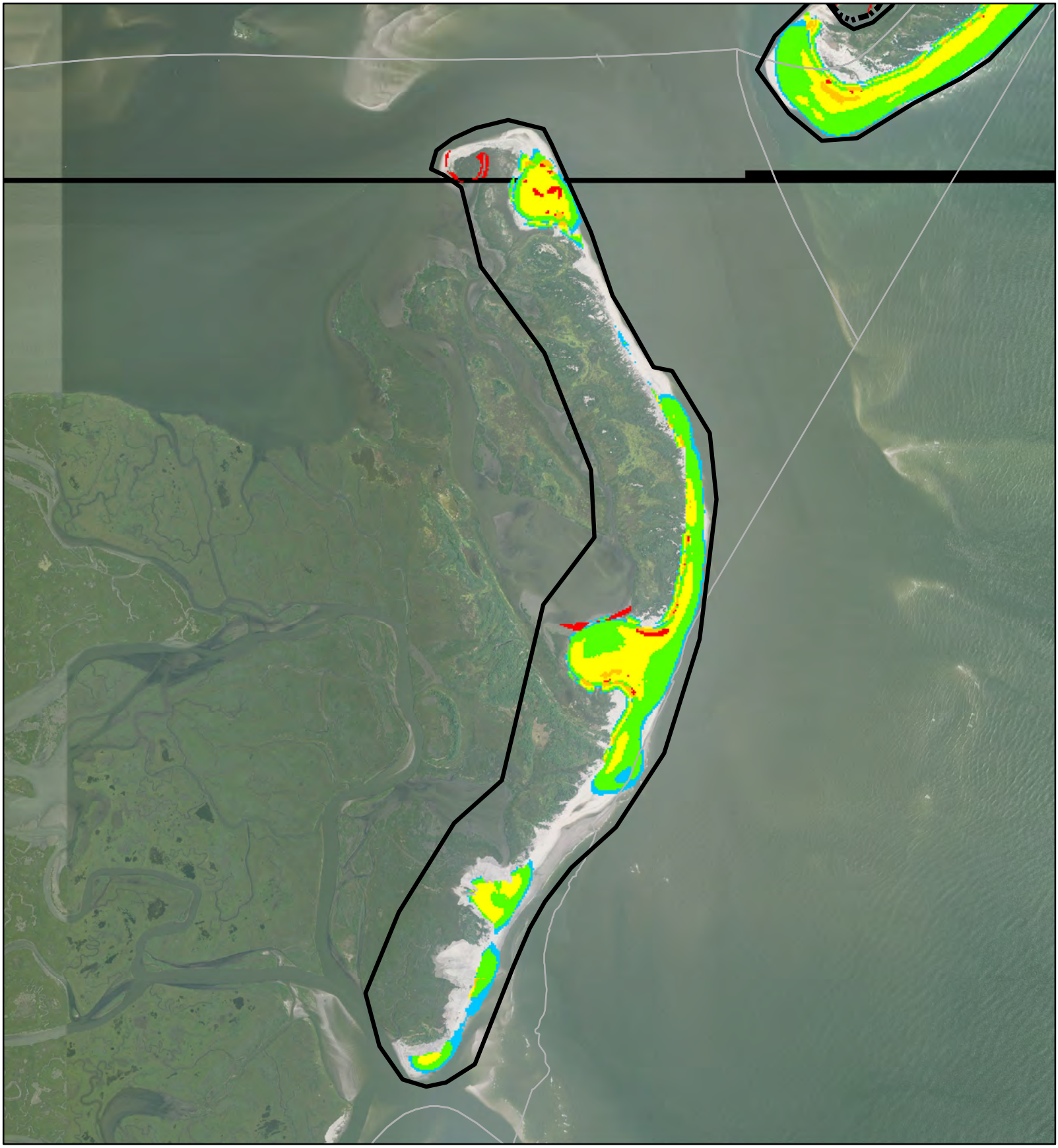
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: EDWIN B. FORSYTHE NWR - HOLGATE & TUCKER ISLAND

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 262.5 525 1,050

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

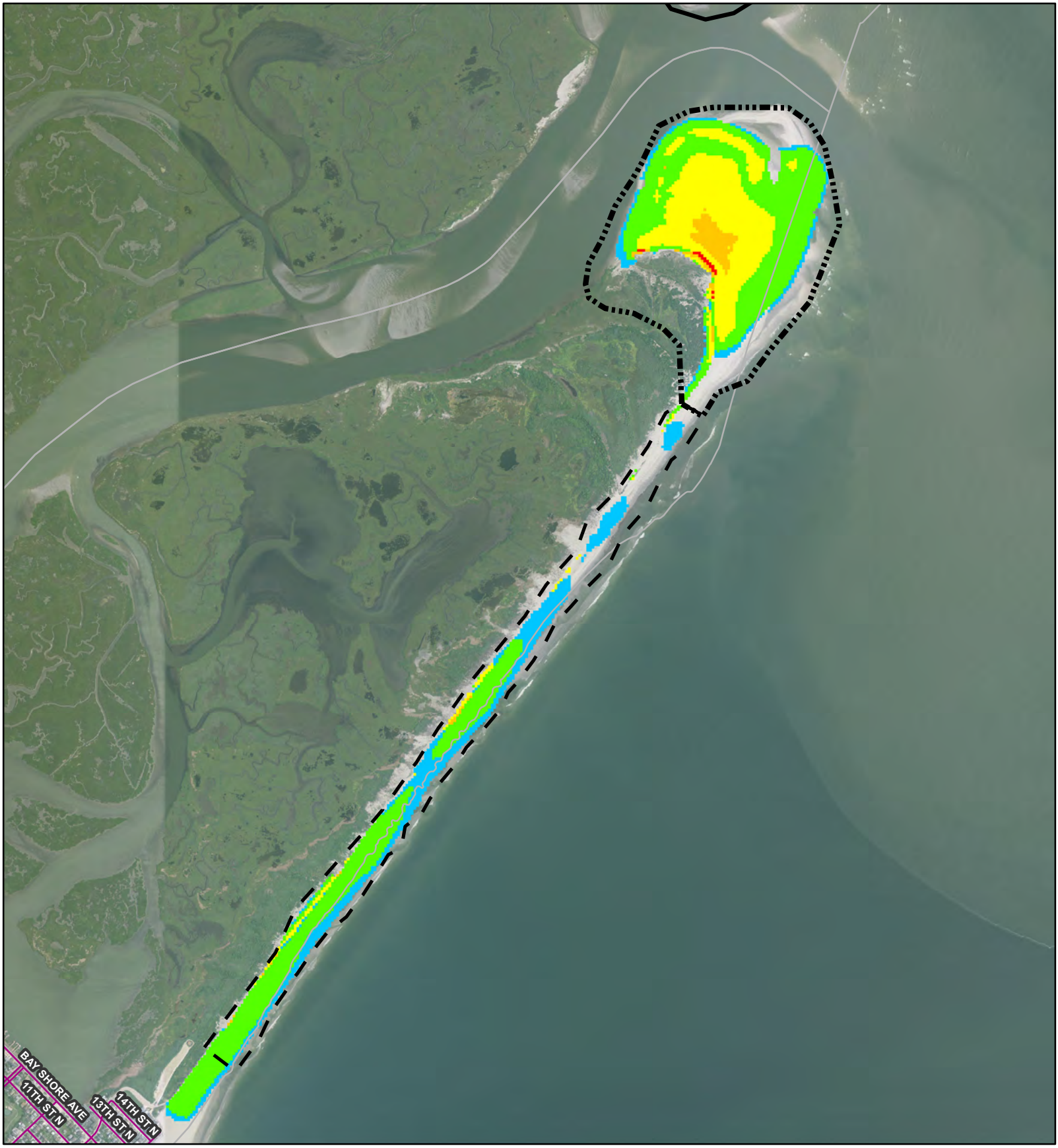
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: LITTLE BEACH

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 180 360 720

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: NORTH BRIGANTINE NATURAL AREA

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

0 305 610 1,220 Meters

N W E S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

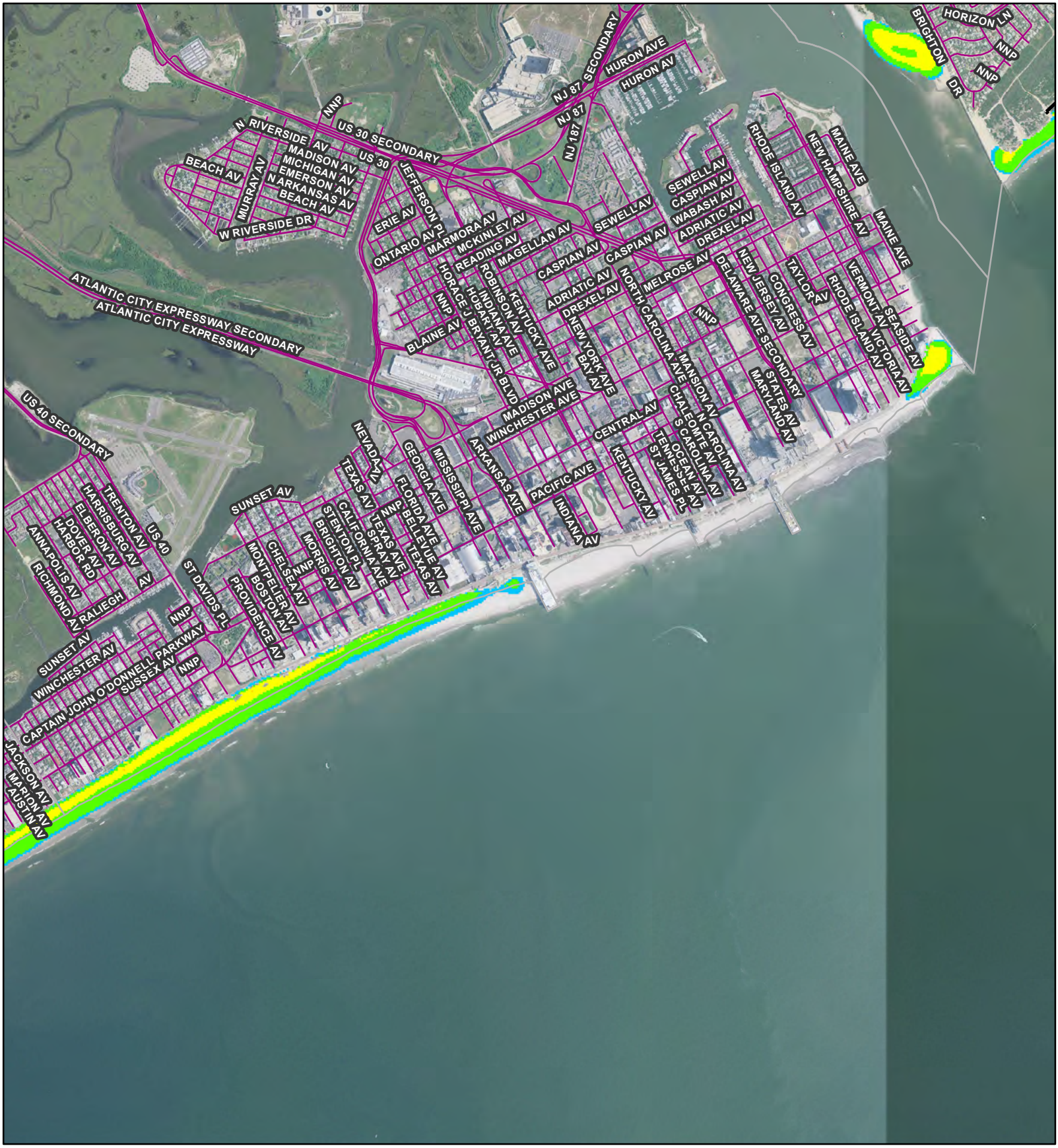
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: BRIGANTINE

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 260 520 1,040

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

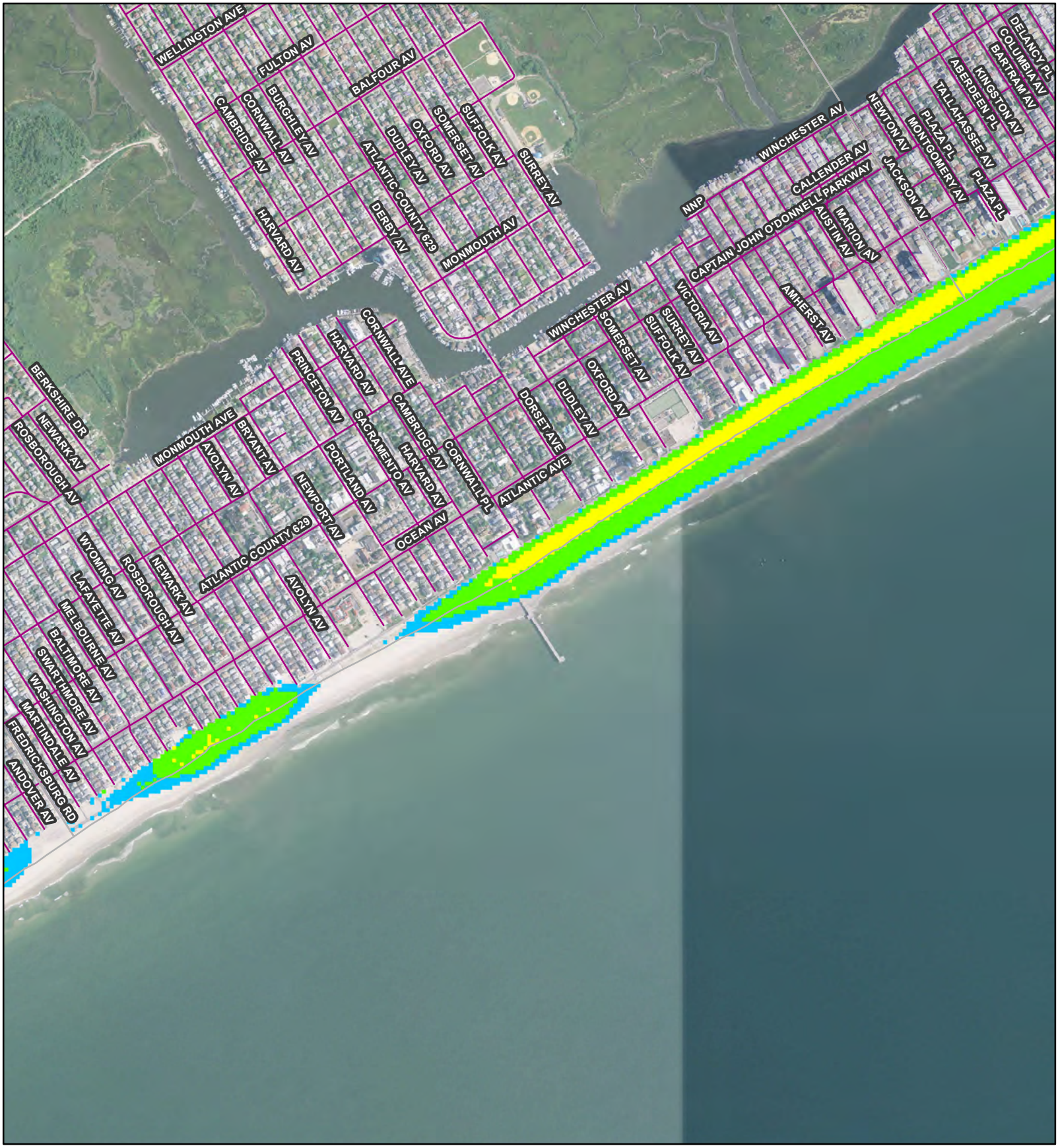
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: ATLANTIC CITY

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 120 240 480

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

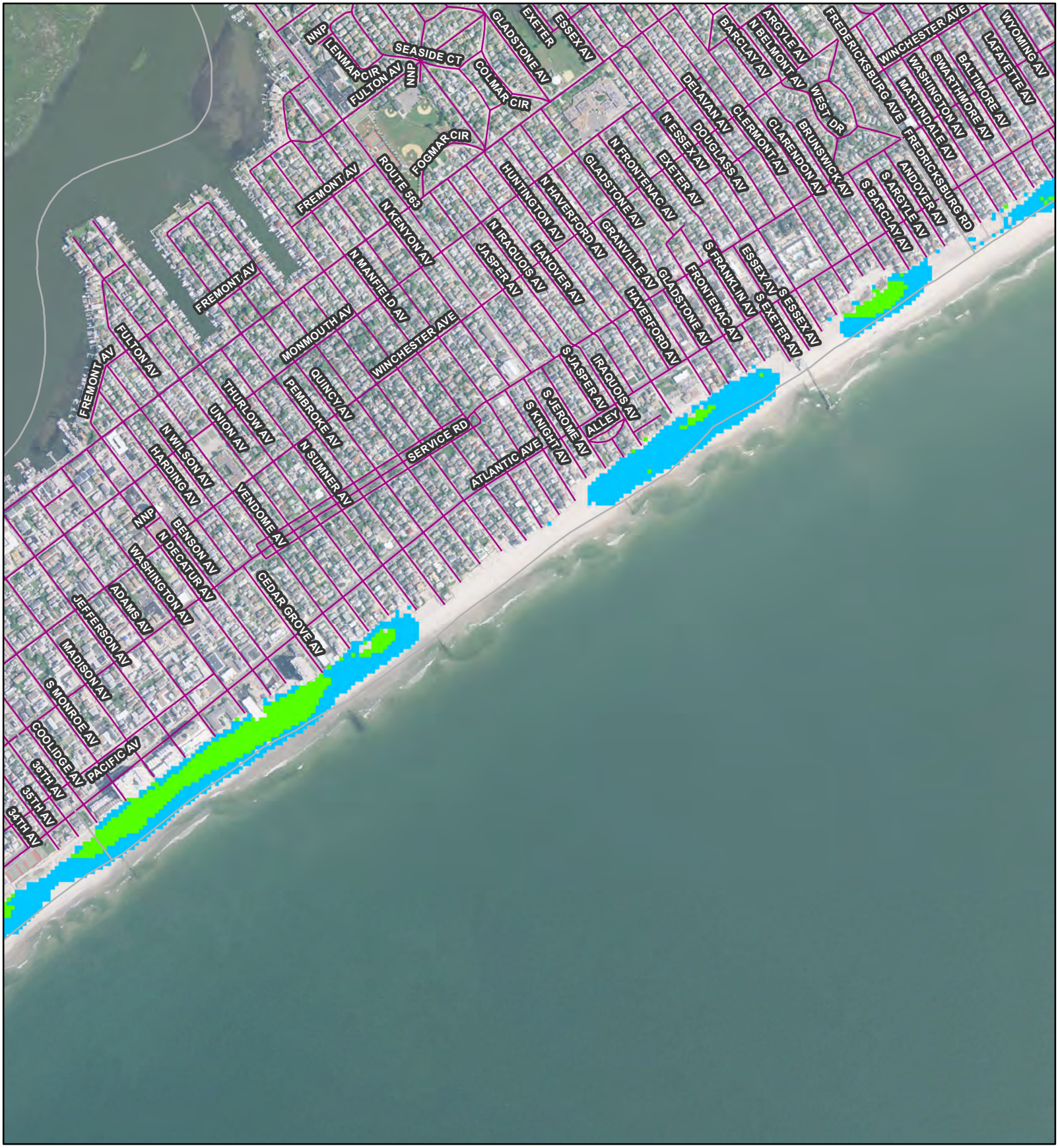
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: VENTNOR CITY

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



0 120 240 480 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: MARGATE CITY

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 115 230 460

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

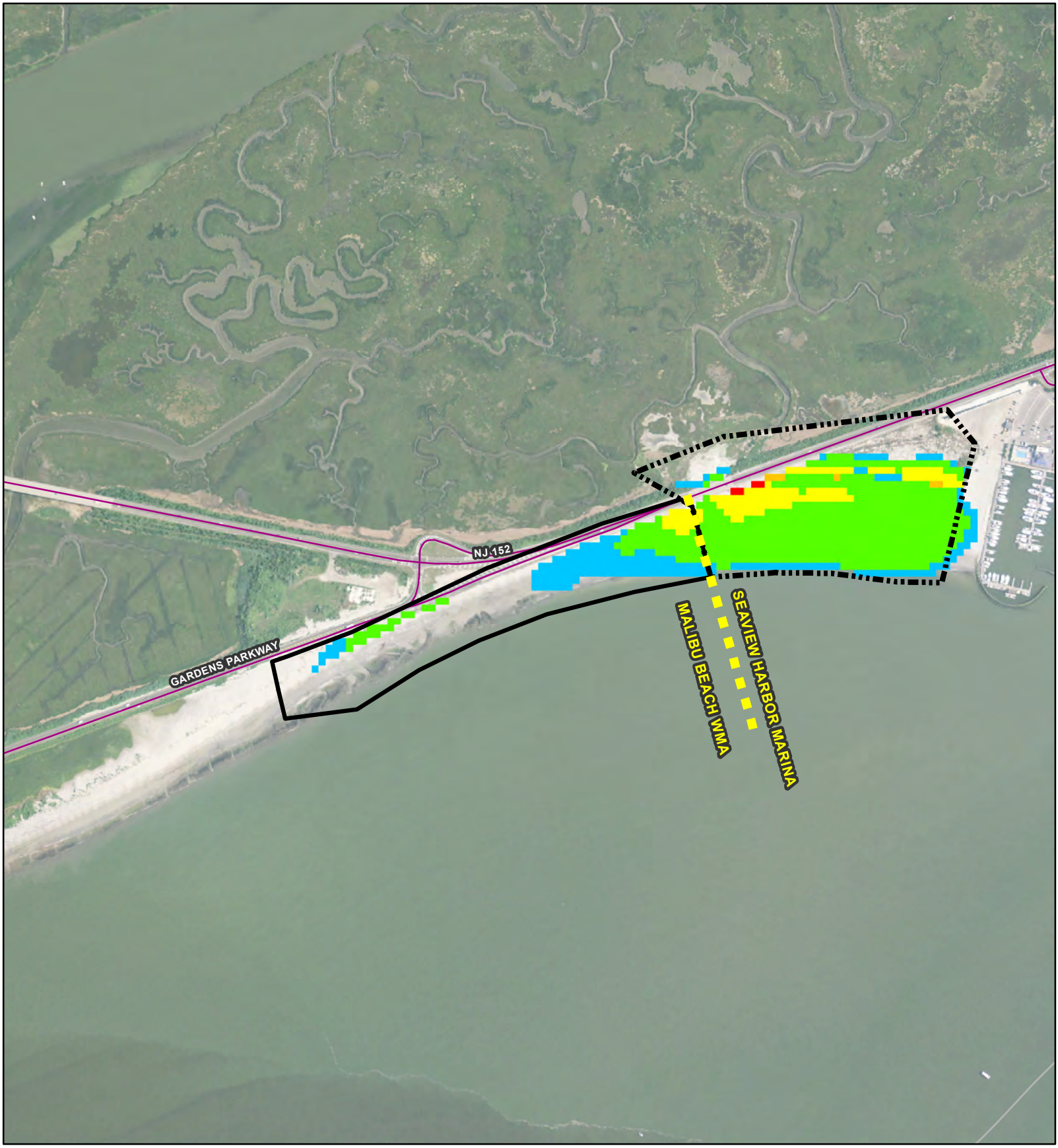
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: LONGPORT BOROUGH

RUTGERS



Meters
0 70 140 280

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEAVIEW HARBOR MARINA & MALIBU BEACH WMA

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 420 840 1,680

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

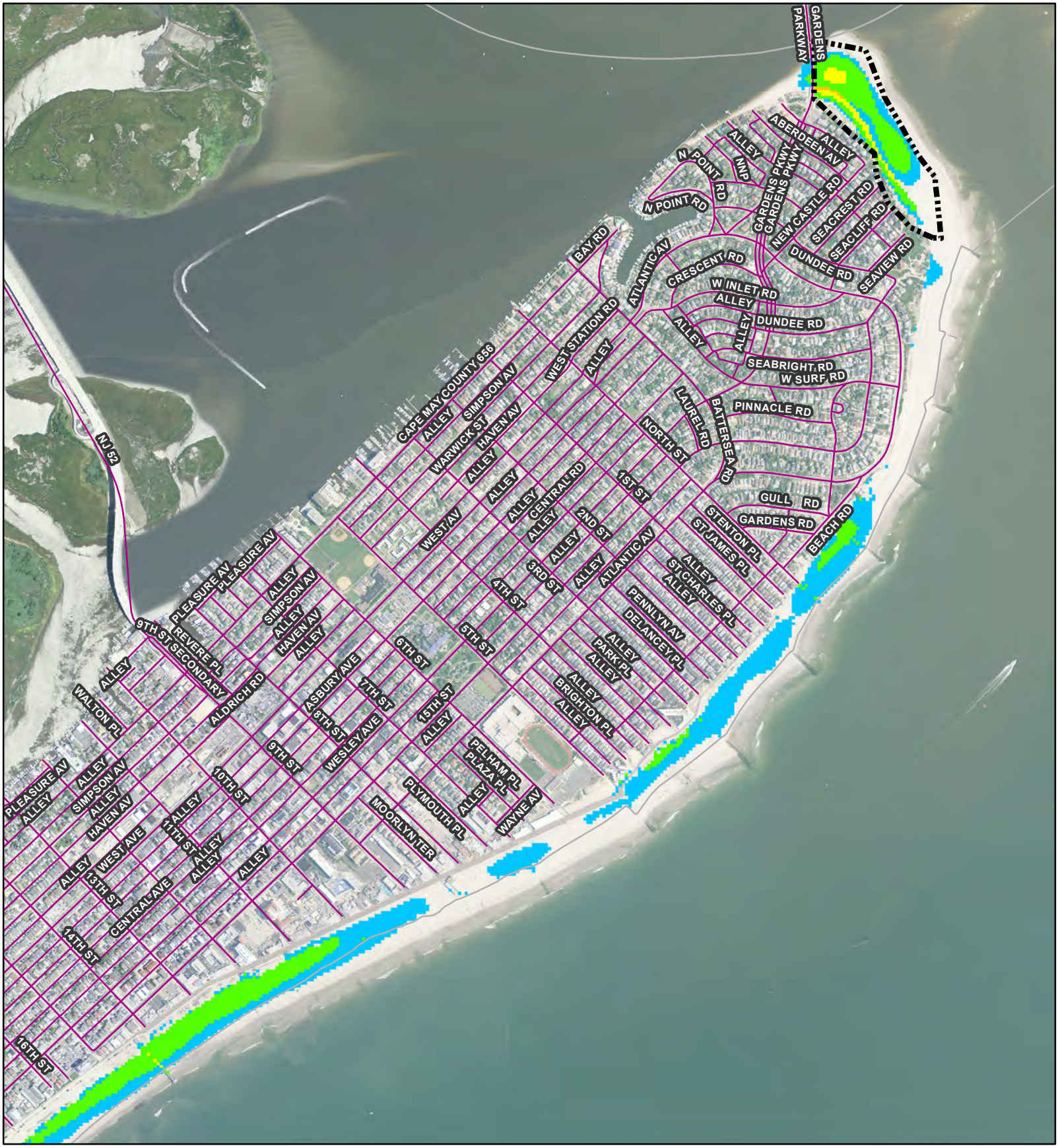
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: OCEAN CITY

RUTGERS



Meters
0 150 300 600

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: OCEAN CITY - NORTH

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 150 300 600

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

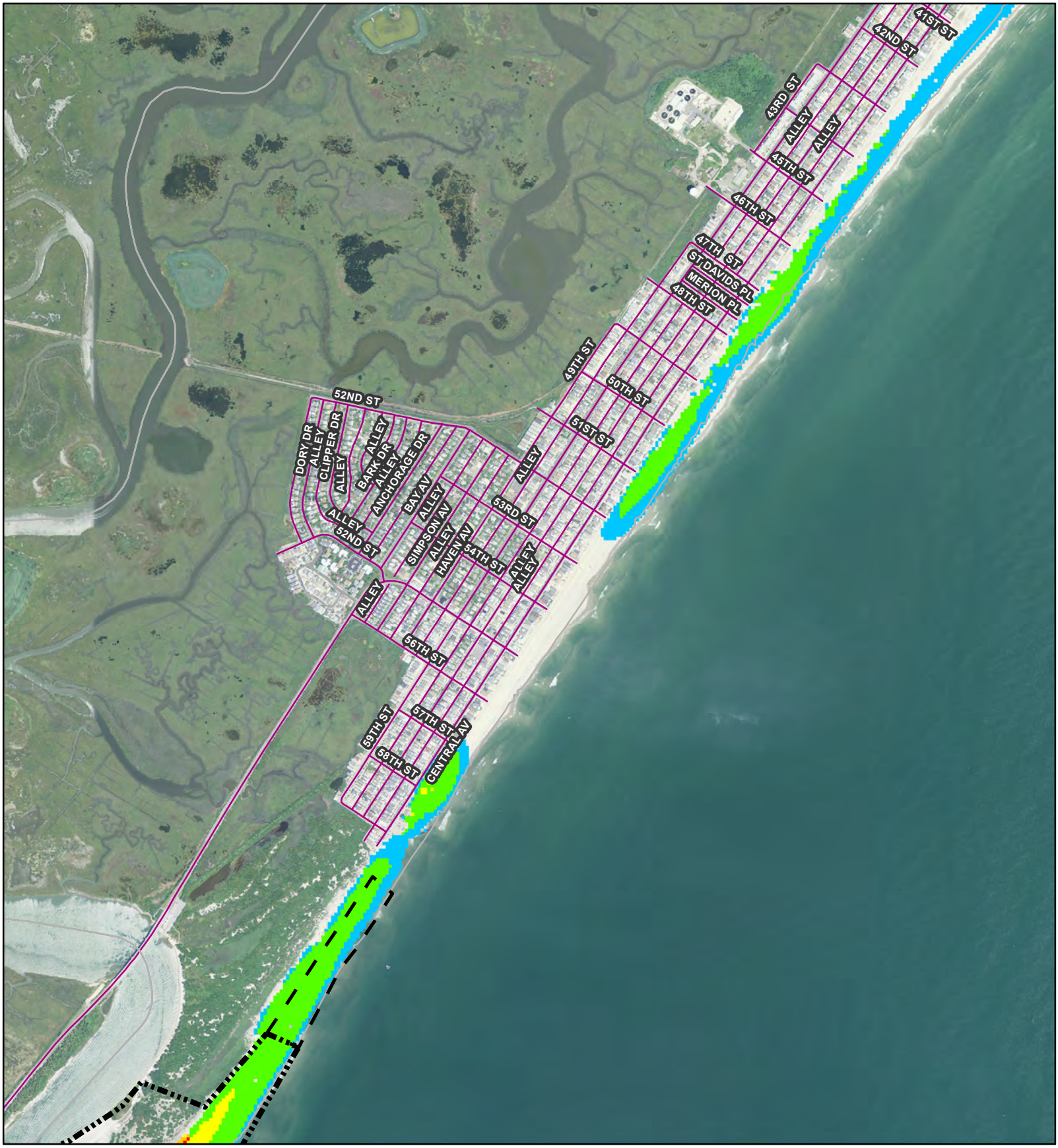
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: OCEAN CITY - CENTRAL

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 150 300 600

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

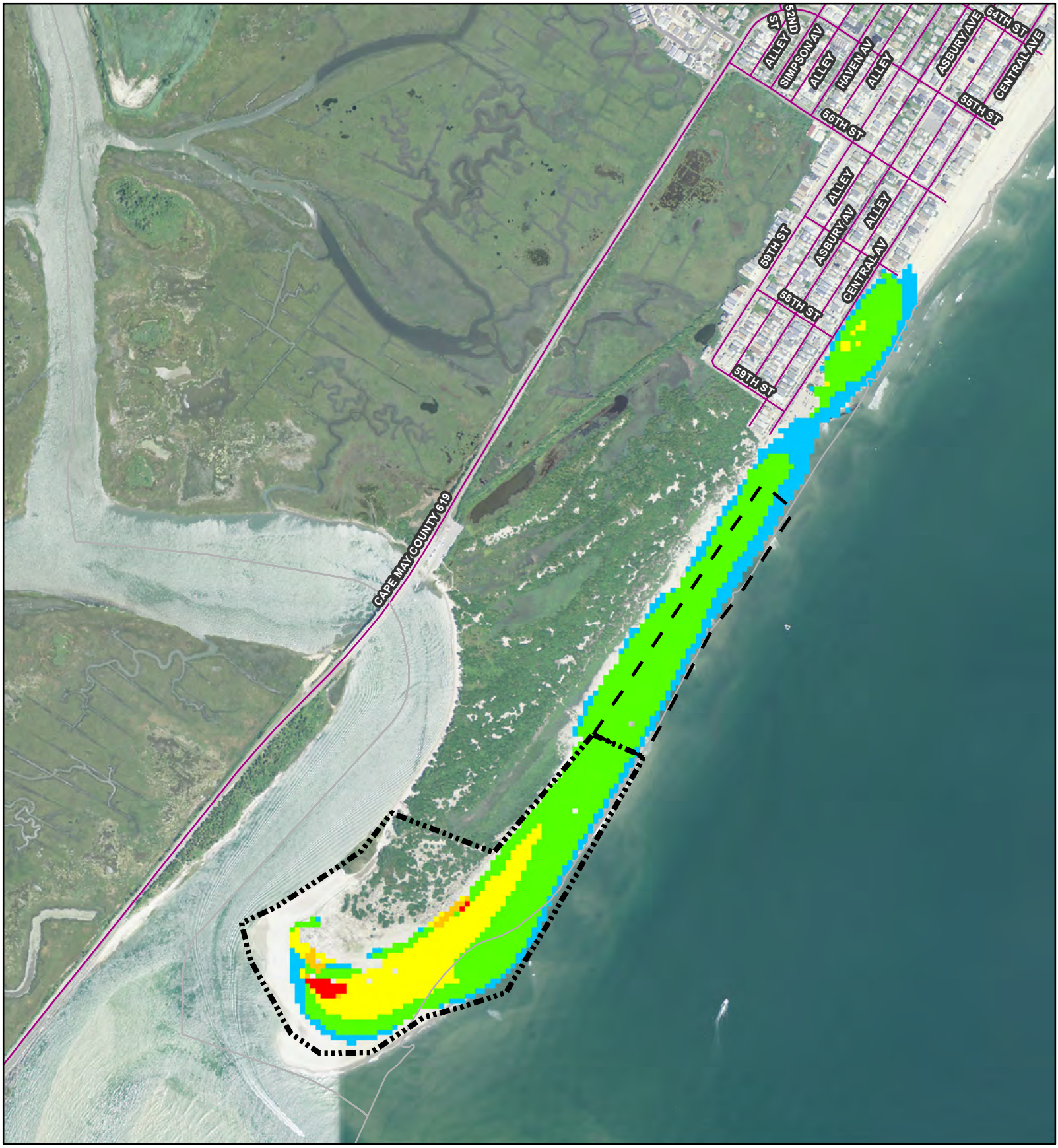
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: OCEAN CITY - SOUTH

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 90 180 360

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

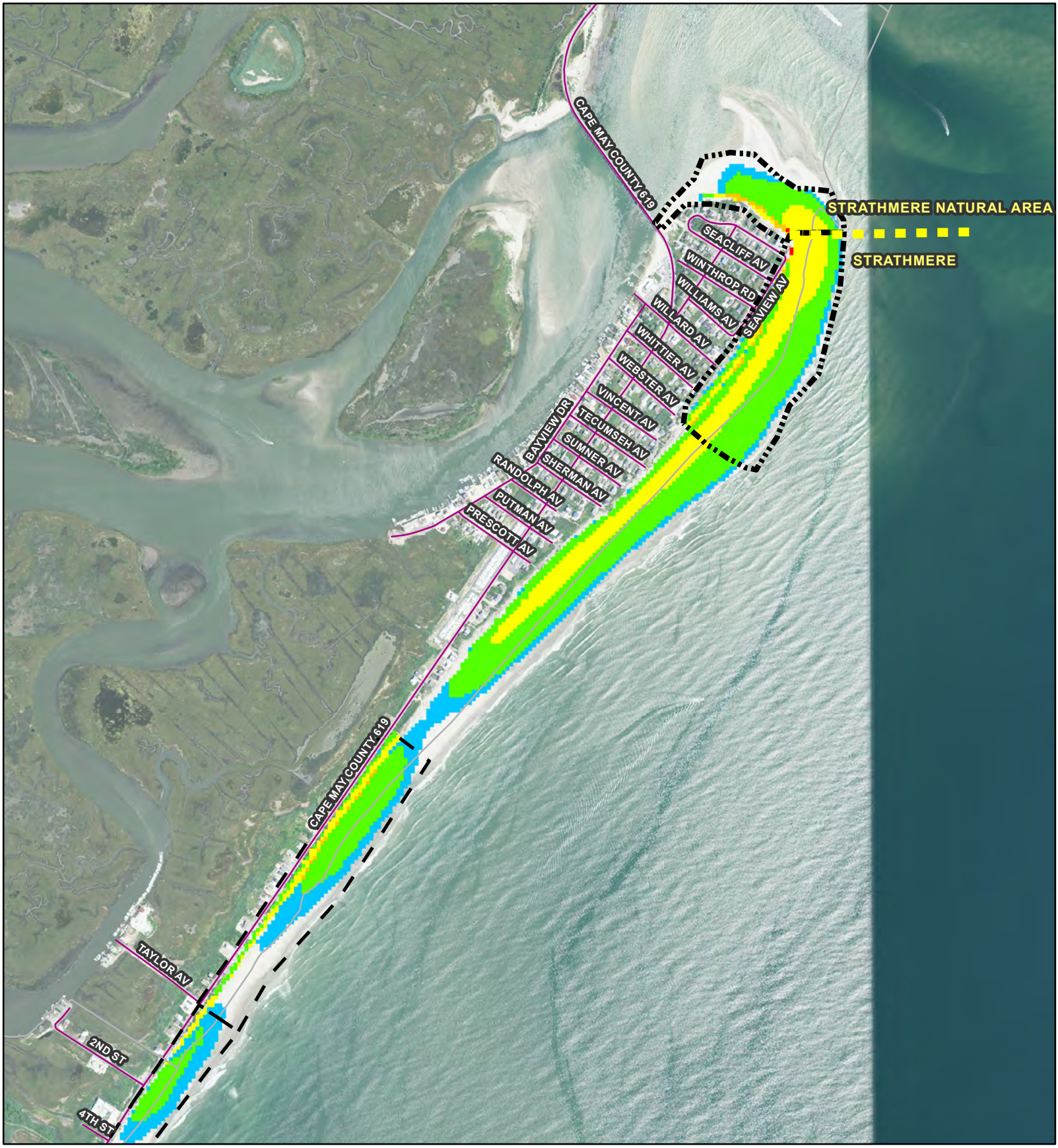
0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: CORSONS INLET STATE PARK

RUTGERS



0 125 250 500 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: STRATHMERE NATURAL AREA & STRATHMERE

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 335 670 1,340

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

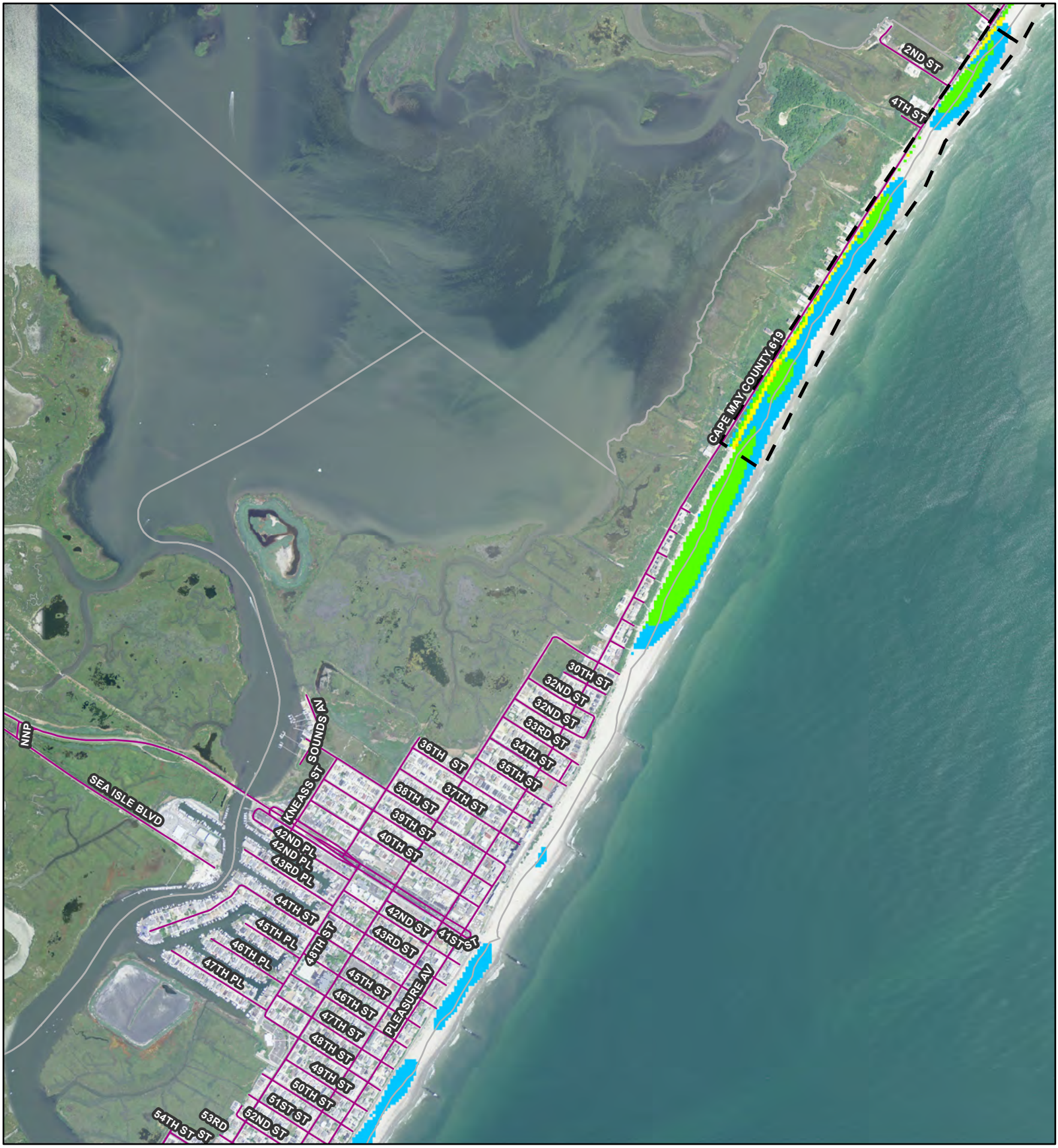
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEA ISLE CITY

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 165 330 660

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

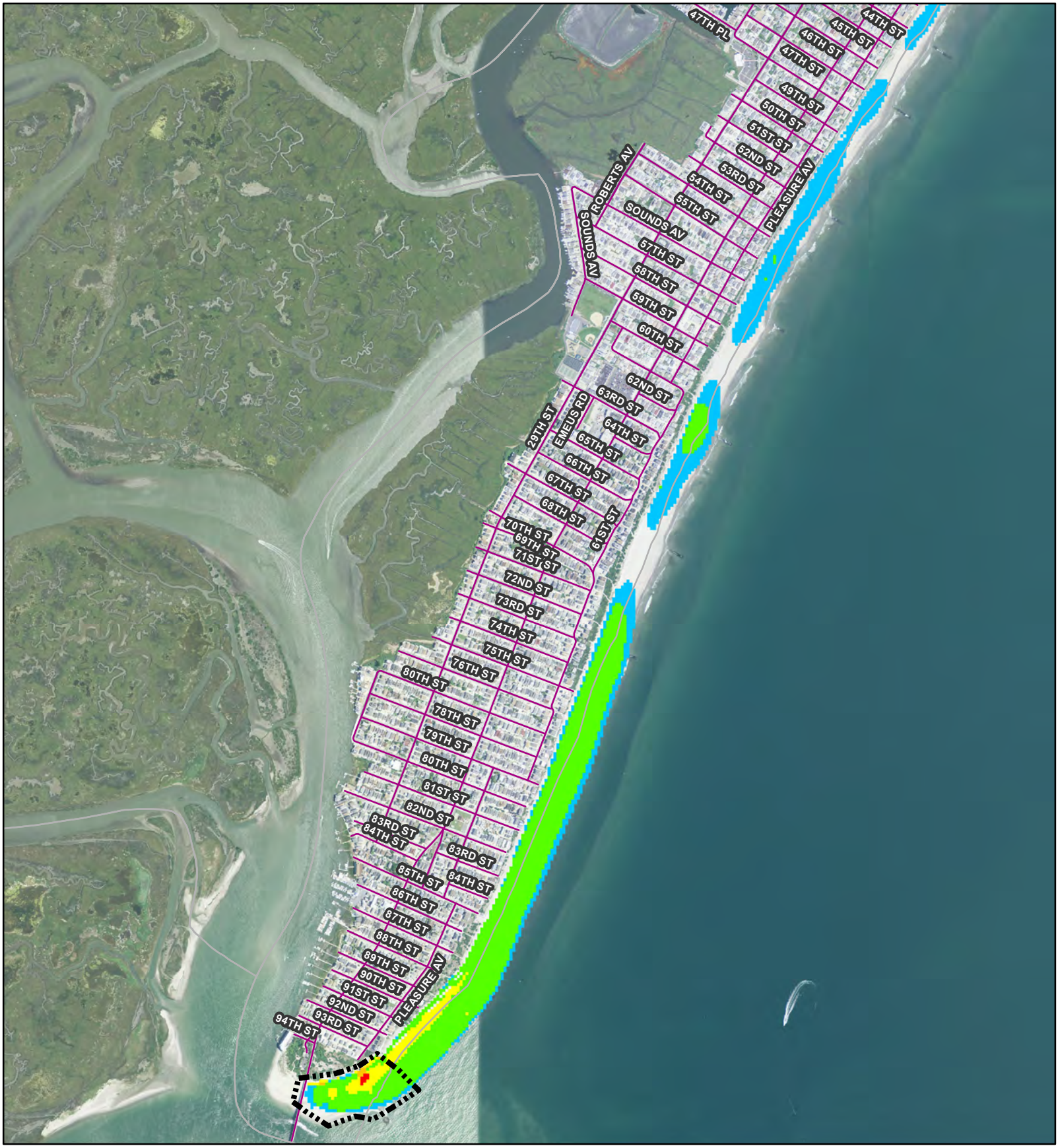
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEA ISLE CITY - NORTH

RUTGERS



Meters
0 162.5 325 650

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

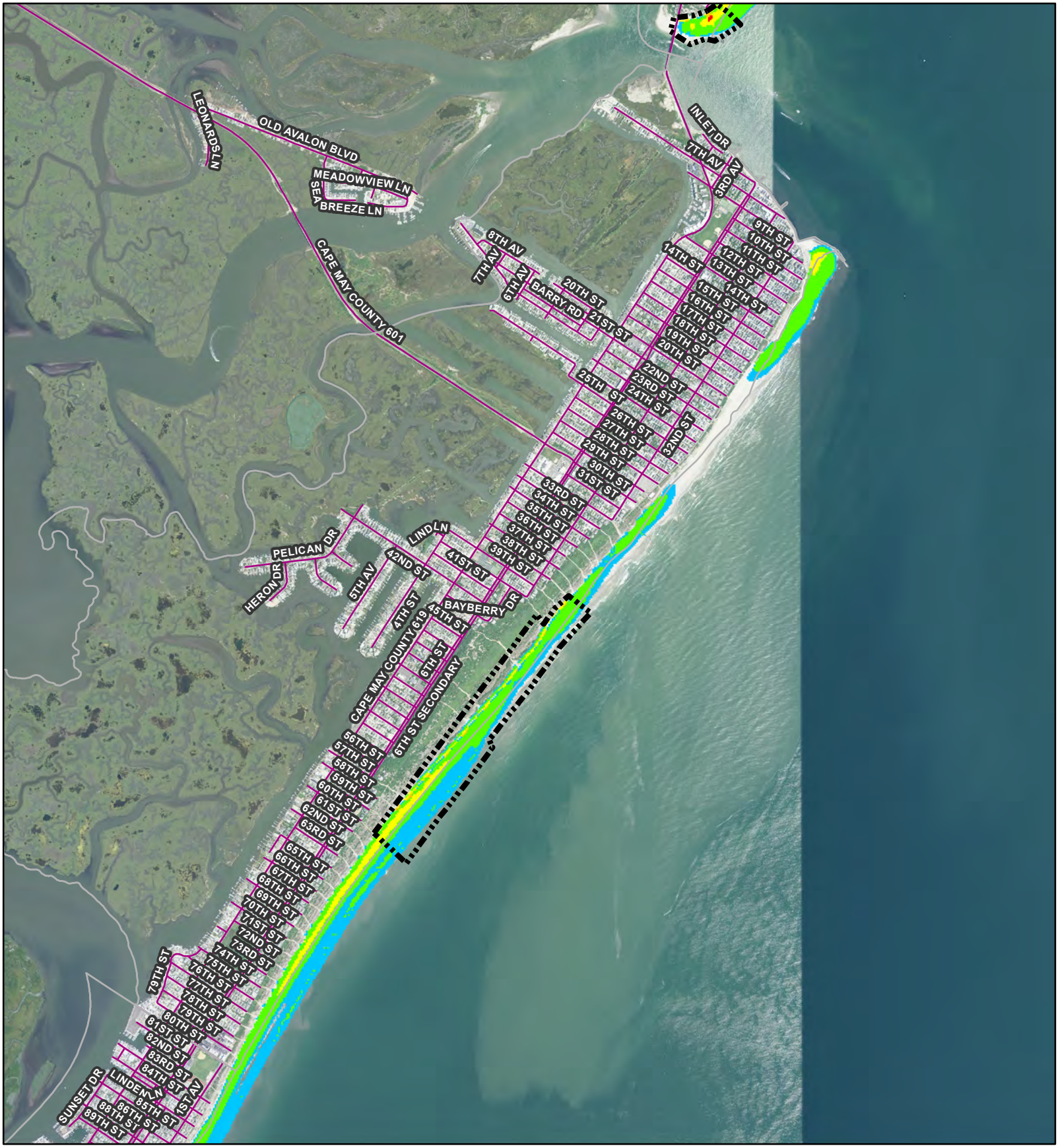
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: SEA ISLE CITY - SOUTH

RUTGERS



0 295 590 1,180 Meters

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: AVALON

RUTGERS

0 162.5 325 650 Meters

N W E S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

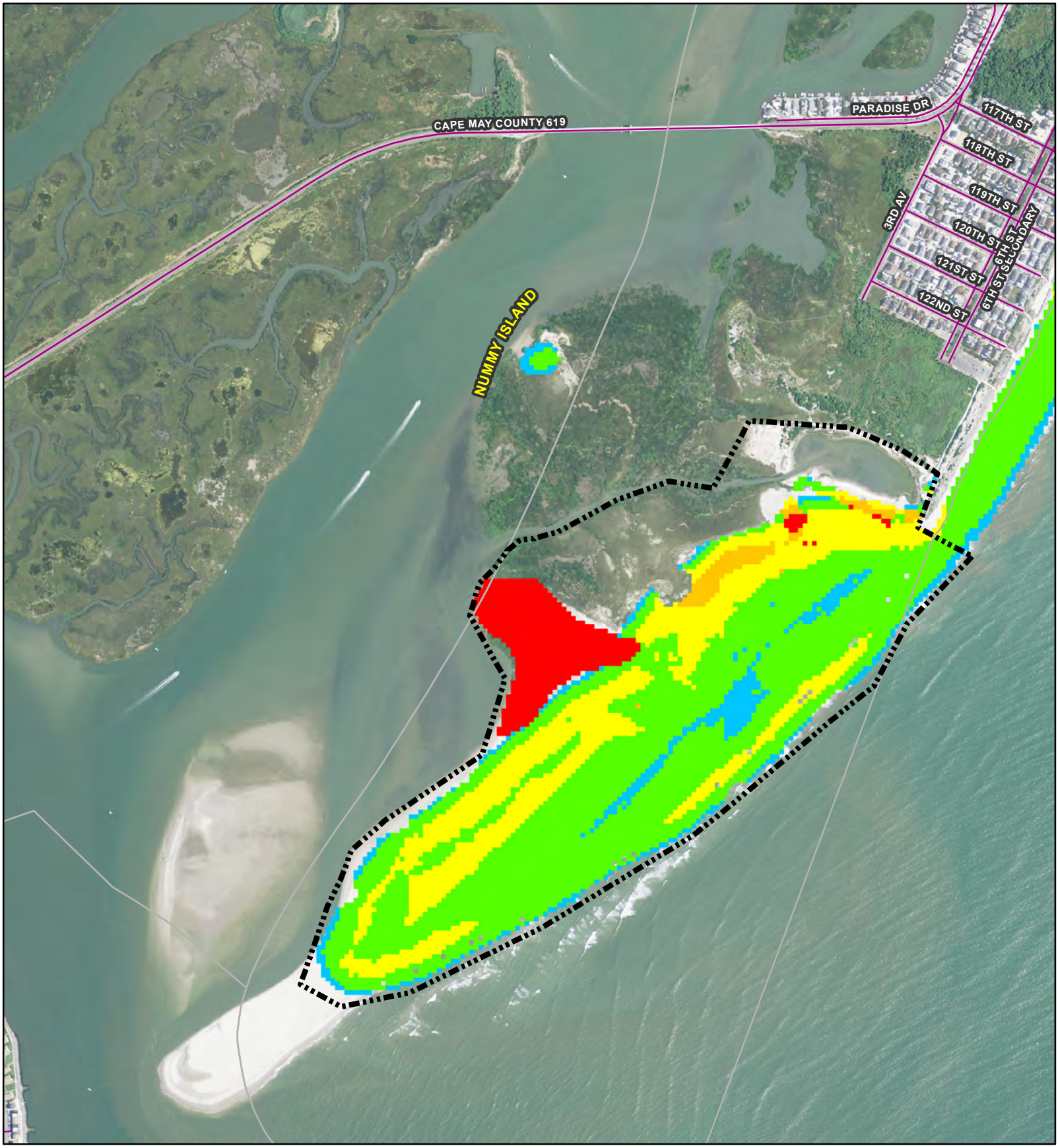
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: STONE HARBOR

RUTGERS



POTENTIAL BEACH-NESTING BIRD HABITAT: STONE HARBOR POINT & NUMMY ISLAND

Meters
0 100 200 400

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 200 400 800

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: NORTH WILDWOOD

RUTGERS

0 105 210 420 Meters

N W E S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

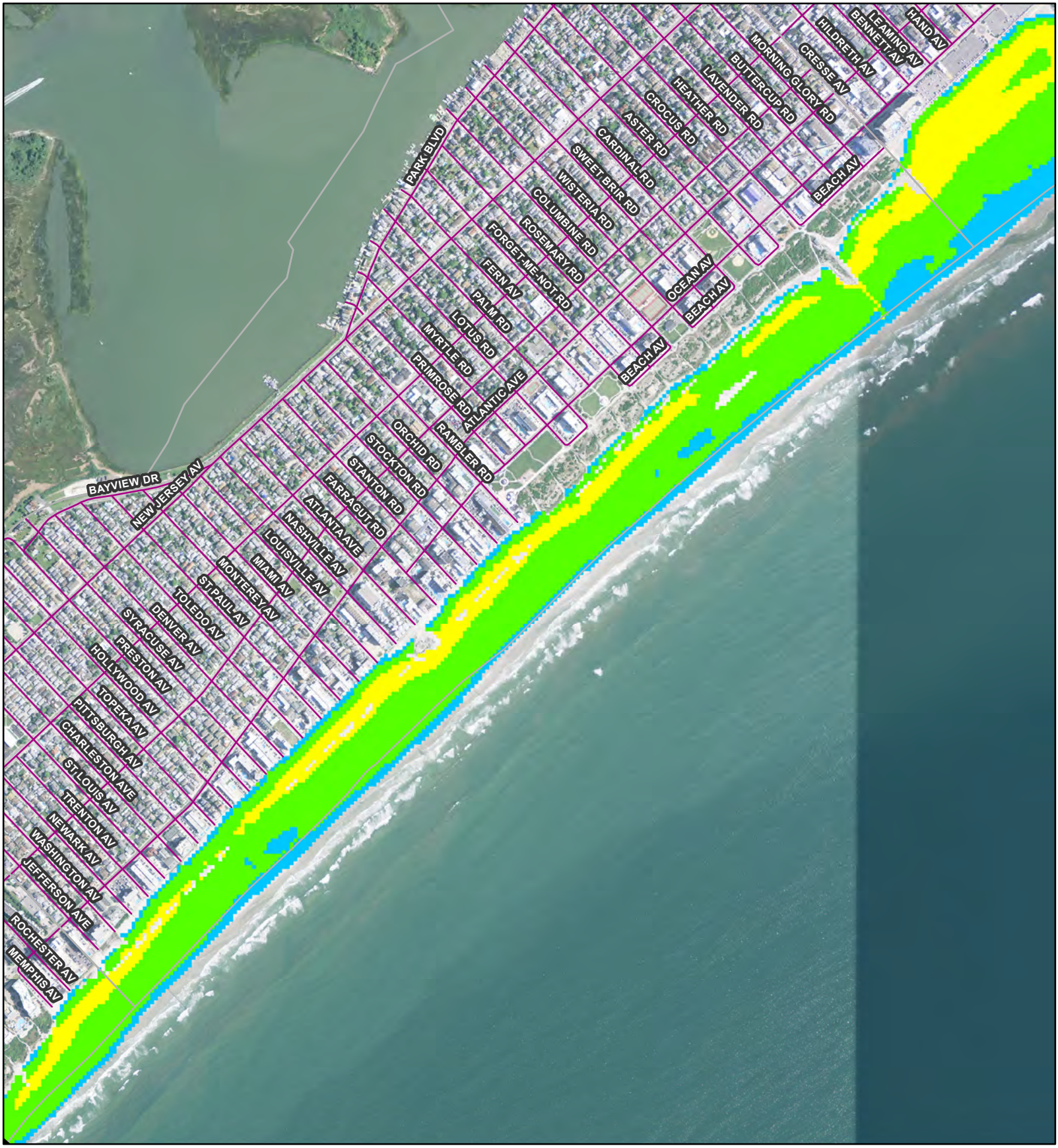
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: WILDWOOD

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 125 250 500

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

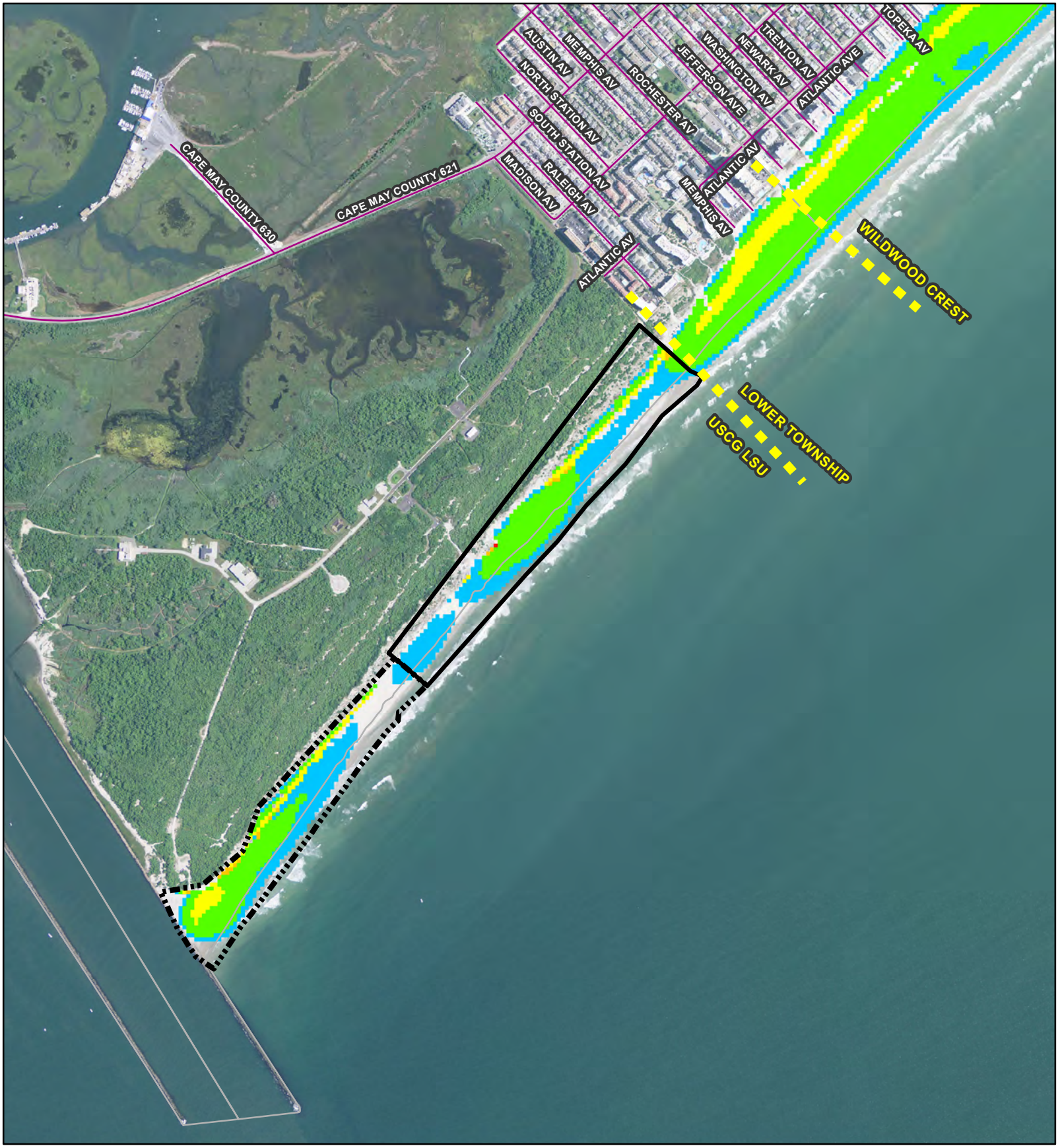
0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: WILDWOOD CREST

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS



Meters
0 120 240 480

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: LOWER TWP & USCG LSU

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

POTENTIAL BEACH-NESTING BIRD HABITAT: USCG TRAINING CENTER

0 95 190 380 Meters

N
W E
S

Municipal boundary

Roadways

Management Zones

Precautionary

Protection

Closed

Probability of occurrence

0.61 - 0.95

0.58 - 0.61

0.55 - 0.58

0.52 - 0.55

0.50 - 0.52

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

RUTGERS

Meters
0 187.5 375 750

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

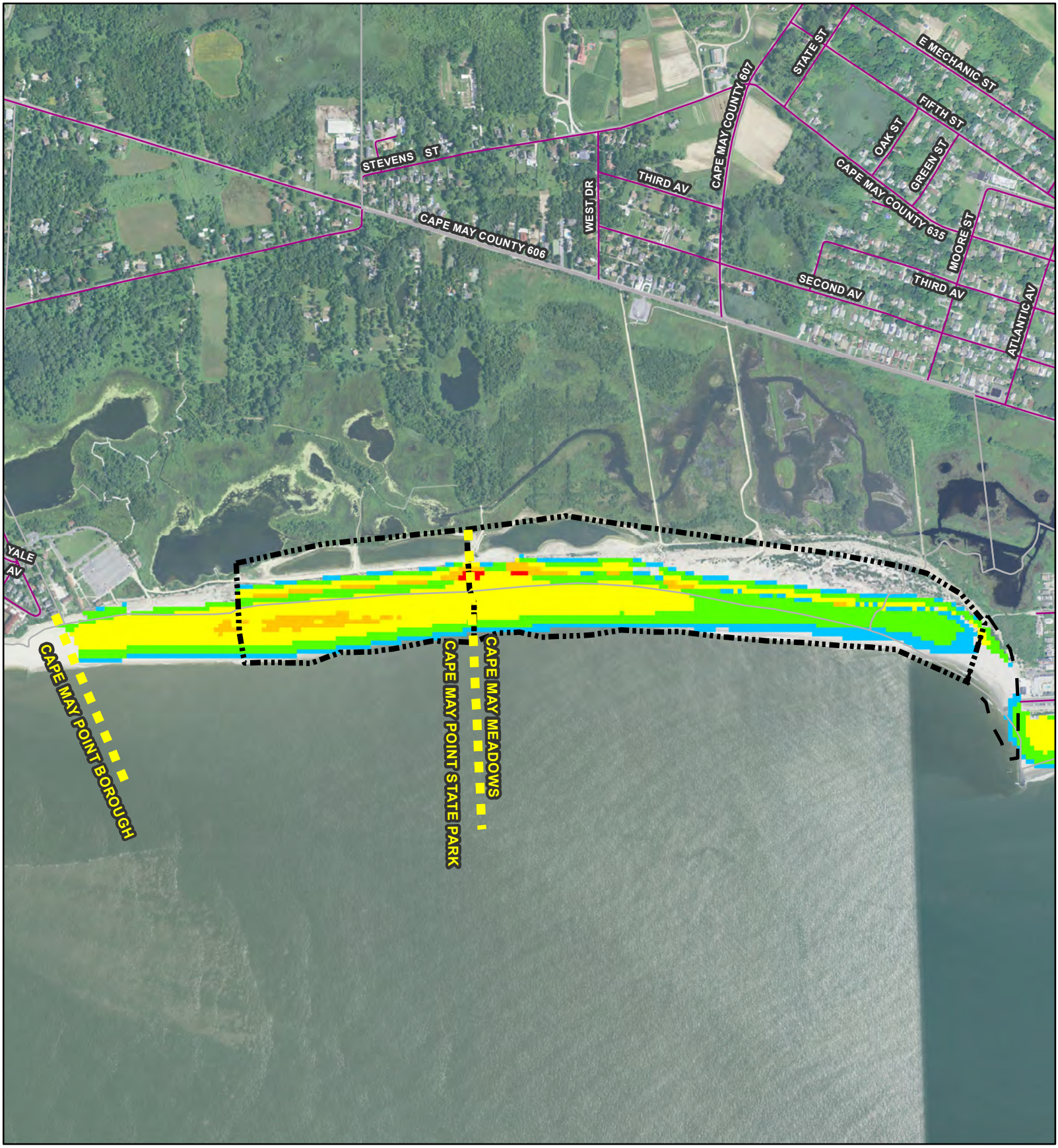
- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: POVERTY BEACH & CAPE MAY

RUTGERS



0 110 220 440 Meters

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: CAPE MAY MEADOWS & CAPE MAY POINT STATE PARK

RUTGERS

Meters
0 60 120 240

N
W E
S

Municipal boundary

Roadways

Aerial imagery from USDA Service Center Agencies 2013. NJ roadway data from NJDOT, Bureau of Transporation Data Development 2010. Municipality boundaries data from NJOIT, Office of Geographic Information Systems 2014.

Management Zones

- Precautionary
- Protection
- Closed

Probability of occurrence

- 0.61 - 0.95
- 0.58 - 0.61
- 0.55 - 0.58
- 0.52 - 0.55
- 0.50 - 0.52

POTENTIAL BEACH-NESTING BIRD HABITAT: CAPE MAY PT BORO

RUTGERS